Vol. 14 JULY, 1931 No. 7

Journal

of the

American Ceramic Society

Abstracts
Vol. 10, No. 7

Bulletin
Vol. 10, No. 7

A Monthly *Journal* Devoted to the Arts and Sciences
Related to the Silicate Industries

Publication Office: 20th & Northampton Sts., Easton, Pa.

Editorial and Advertising Offices: 2525 N. High St., Columbus, Ohio.

Executive Office: 2525 N. High St., Columbus, Ohio.

Committee on Publications: J. T. LITTLETON, *Chairman;* L. NAVIAS, L. J. TROSTEL, A. E. R. WESTMAN, ROSS C. PURDY.

Entered as second class matter at the post office at Easton, Pa., under the Act of March 3, 1879.

(Copyright 1931, American Ceramic Society)

Subscription Fifteen dollars a year. Single numbers one dollar and one-half
(Foreign and Canadian postage, 50c additional on subscriptions)

Established 1869

B. F. DRAKENFELD & CO.

Incorporated

45-7 Park Place New York

Pioneer and Premier Producers of
Vitrifiable Colors in America

OXIDE COLORS

FOR ENAMELERS

Manufactured Throughout under
Strict Chemical Control

SPECIAL AND UNIQUE
COLOR SHADES

Prepared to Meet Individual
Requirements

Order Direct or through Following Agents

FERRO ENAMEL SUPPLY CO.
CLEVELAND, OHIO

BRAUN CORPORATION
LOS ANGELES, CALIF.

You're *Free* from "cold-junction" errors

With L&N POTENTIOMETER PYROMETERS

Actual width of the L & N Chart is 9¼ inches

BECAUSE of the electrical principle* upon which it is built, the L & N Potentiometer Pyrometer offers the simplest and most reliable automatic compensation for "cold-junction" temperature changes. A small spool of nickel wire, mounted on the terminal panel, varies in resistance with changes in temperature at the instrument.

Positive, mathematically accurate and free from moving parts, it provides absolute protection against cold-junction errors.

The greater accuracy and complete reliability of L & N Potentiometer Pyrometers is leading thousands of plants to better results in heat-treating processes.

L & N Catalog 84-K lists L & N Potentiometer Pyrometers for automatic temperature control. Catalog 87-K lists them for recording and for indicating. Special bulletins outline their application to various industries.

** Information as to the advantages of L & N Potentiometers will be sent on request.*

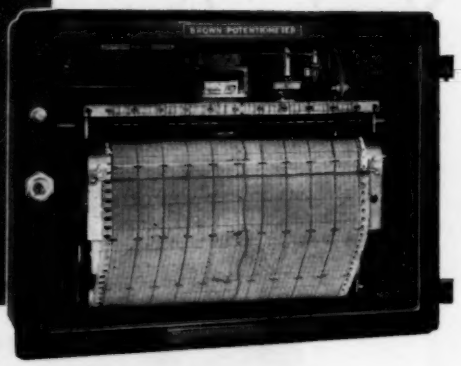
LEEDS & NORTHRUP COMPANY
4901 STENTON AVENUE PHILADELPHIA, PA.

LEEDS & NORTHRUP

P-208 Cleveland Chicago Houston Los Angeles San Francisco

Different Pyrometers—The Most Accurate Pyrometers In Industry
For Indicating, for Recording and for Controlling Automatically

More than
50
New Features
in this
New Brown
Potentiometer
Pyrometer



---founded
on

70 Years of

experience in helping industry measure temperatures accurately!

For seventy years The Brown Instrument Company has been building temperature measuring instruments for industry. All of these years of experience are back of the new Brown Potentiometer Pyrometer.

Brown Potentiometer Catalog No. 1101 Sent on Request.

There are more than fifty new features in the new Brown Potentiometer Pyrometer. Features such as the extra long slide wire for greater accuracy—slide wire and balancing rheostat immersed in oil for protection against wear and corrosion—non-slip driving clutch—humidity compensator for chart—extra housing for galvanometer—interchangeable mounting of cases—and many others.

Details of these remarkable advantages are described in Catalog 1101. Write for copy.

THE BROWN INSTRUMENT COMPANY
4484 Wayne Ave., Philadelphia, Pa.
Branches in 22 principal cities

BROWN POTENTIOMETER PYROMETER
Brings Laboratory Accuracy to Industry

Table of Contents

JULY, 1931

The Journal

Reinforced Brick Masonry—Lent 469
Effects of Body Composition and Firing Treatment on Salt Glazes—Hursh and Clemens 482
Sodium Silicate, A New Enamel Raw Material—Manson 490
Control of Draining Consistencies of Enamels by Addition of Sodium Silicate—Bennett 495
Power Cost on an Electric Enameling Furnace—Manson 499
Viscosity of Glass between the Strain Point and Melting Temperature—Lillie 502
Design and Construction of Polariscopes for Use in Glass Factories—Spencer and Jones 512
The Index of Refraction of Some Soda-Lime-Silica Glasses as a Function of the Composition—Faick and Finn 518
The Devitrification of "Pyrex" Glasses—Morey 529

Ceramic Abstracts

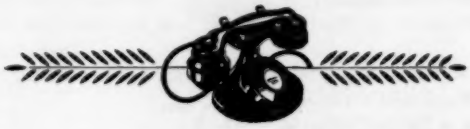
469

The Bulletin

Editorials
School Training 195
Ohio Is Honored by a Few of Her Early Graduates 197
Papers and Discussions
1930 Progress Report of the Refractories Division Research Committee 199
Second Tableware Progress Report 205
Bibliography of Bibliographies 211
Activities of the Society
Report of Committee on Rules Concerning Fellows 245
Constitution and By-Laws of the AMERICAN CERAMIC SOCIETY 245
President Eskesen Attends Meeting of French Ceramic Society 257
Materials and Equipment Division 257
Local Section News:
Baltimore-Washington Section 258
Pittsburgh Section 258
New Members Received in May 259
Roster Changes in May 260
Notes and News
Dr. Charles Fergus Binns 261
More Honors to Edward Orton, Jr. 261
Necrology:
Porter S. Kier 262
Dean Samuel Walker Beyer 263
The Ohio Ceramic Industries Association 263
New Jersey Clay Workers Association 264
Chicago District Enamelers Club 264
Calendar of Meetings 264
Advertisers' Index 13

SAVING MONEY

FOR TELEPHONE SUBSCRIBERS



DURING the past fifty-five years, the constant effort of the Bell System has been to provide efficient telephone service for all the people at the lowest possible price. There are many instances of substantial savings for subscribers.

Since the latter part of 1926 the reductions in long distance rates have been particularly marked. For example, a telephone call across the country from New York to San Francisco now costs $9 instead of $16.50. Reductions have also been made for lesser distances. As a result of these rate reductions telephone users are now saving the substantial amount of $20,000,000 annually.

You, as a telephone subscriber, are constantly receiving extra value from your telephone—because the number of subscribers is increasing, and the more people you can reach by telephone, the more valuable it is to you.

Today, there are few things purchased by the family or by a business that give so much useful service at such low price as the telephone.

Every time you pick up the telephone you become part of a communication system that uses eighty million miles of wire and represents an investment of more than four thousand million dollars. Yet the cost of local service that puts you in direct personal touch with thousands or hundreds of thousands of people in your town or city is only a few cents a day.

★ *AMERICAN TELEPHONE AND TELEGRAPH COMPANY* ★

REINFORCED BRICK MASONRY[1]

By Major L. B. Lent[2]

ABSTRACT

A descriptive presentation of the practical use of reinforced brick masonry is given together with a historical survey of the development of its use.

I. Introduction

Reinforced brick masonry is commanding increasing interest in this country. Many believe it to be a recent development, but this is far from the truth, for this form of construction is nearly 100 years old, perhaps older.

The recently developed interest must be credited to the Common Brick Manufacturers' Association of America. Since this paper is a descriptive and not an academic presentation of the subject, a short sketch of the development of the art in this country is pertinent.

In 1923, Eugene S. Powers, an architect in Philadelphia, published a booklet entitled, "Adhesive Construction in Brickwork," in which he emphasized the fact that mortar exerted an appreciable cohesive force in brick masonry, and that when reinforcing steel was placed in the proper position in beams or slabs they functioned according to the theory of such structures, and developed flexural strengths equal to similar construction in reinforced concrete.

The interest of our Association was at once aroused and some tests of reinforced brickwork lintels were made at the Case School of Applied Science, Cleveland, Ohio, in the latter part of 1923, and were reported in January, 1924.

Tests of reinforced beams were also made at the University of Washington, Seattle, Washington, and reported to us in 1925.

In the summer of 1927, Mason Vaugh, after several years' work in India, brought two volumes constituting the classic report of Brebner[3] to the Government of India on reinforced brickwork. This report, and Mr. Vaugh's account of his own experience, showed that reinforced brickwork had been used extensively in many kinds of structures in that far-off country and converted our interest from a passive to an active one.

Information furnished by Vaugh was the basis of an article by the writer which was published in the *Engineering News-Record*, February, 1929.

Dr. W. K. Hatt, Purdue University, after reading this article, called

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Structural Clay Products Division). Received March 14, 1931.

[2] Chief Engineer, The Common Brick Manufacturers' Assn. of America.

[3] A. Brebner, "Reinforced Brickwork," Govt. of India, Public Works Department, *Tech. Paper*, No. 38.

our attention to the fact that Mark J. Brunel had done some remarkable pioneer work on reinforced brickwork in England in 1836. This is the first example of which we have any knowledge.

Brunel built two balanced sections of a cantilever arch over a central pier of brickwork, with iron bar reinforcement in which the brickwork was laid without centering or forms of any kind, the work being done from scaffolds hung from the top side of the brickwork as it proceeded. This cantilever arch projected 60 feet from the central pier, so that a mating arch on another pier would have given a complete span of 120 feet, as shown in Fig. 1.

Space does not permit of an extended description of this classic experi-

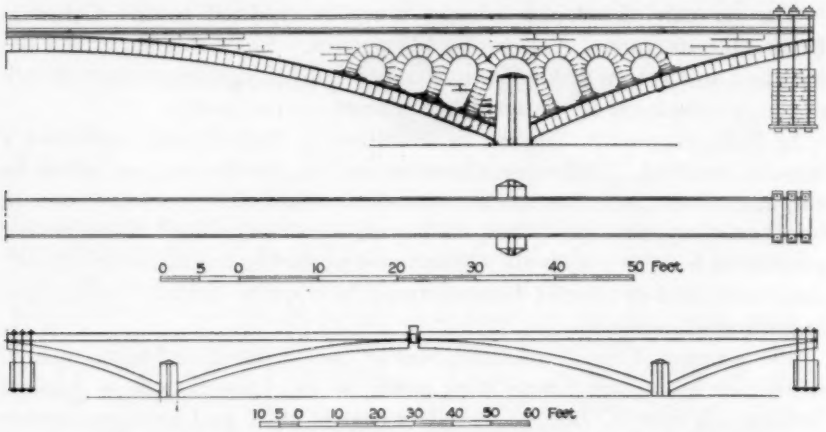


FIG. 1.—Mr. Brunel's experimental brick and cement arch, erected in the yard at the Thames Tunnel Rotherhithe. Top: elevation. Center: plan. Bottom: elevation of a bridge, constructed on the principles of an experimental arch.

ment or of other tests by Brunel and his associates on reinforced brickwork beams. Just why this form of construction was not put into practical use is not altogether clear, but probably because skeleton frame buildings, as we know them today, did not then exist.

In 1928, at our annual convention, the writer called attention to the possibilities in reinforced brickwork, and this subject was discussed quite thoroughly at our engineers' conference at that time and at all subsequent meetings. As the result of this, Judson Vogdes, engineer of the Philadelphia district, built and tested reinforced brickwork lintels in Philadelphia in 1929, obtaining most satisfactory results as to strength. And in 1930, Hugo Filippi, engineer of the Chicago district, built and tested both beams and slabs. The results of both these tests are given in this paper.

Experiments by the writer in Cleveland, 1930 and 1931, are not yet

complete, but show that the strengths of typical precast floor slabs of reinforced brickwork are entirely satisfactory.

From the above, it must be apparent that the interest in reinforced brickwork in this country has been fostered and developed by the Common Brick Manufacturers' Association.

We now have sufficient data regarding the performance of reinforced brickwork to venture the assertion that it can safely be used in many

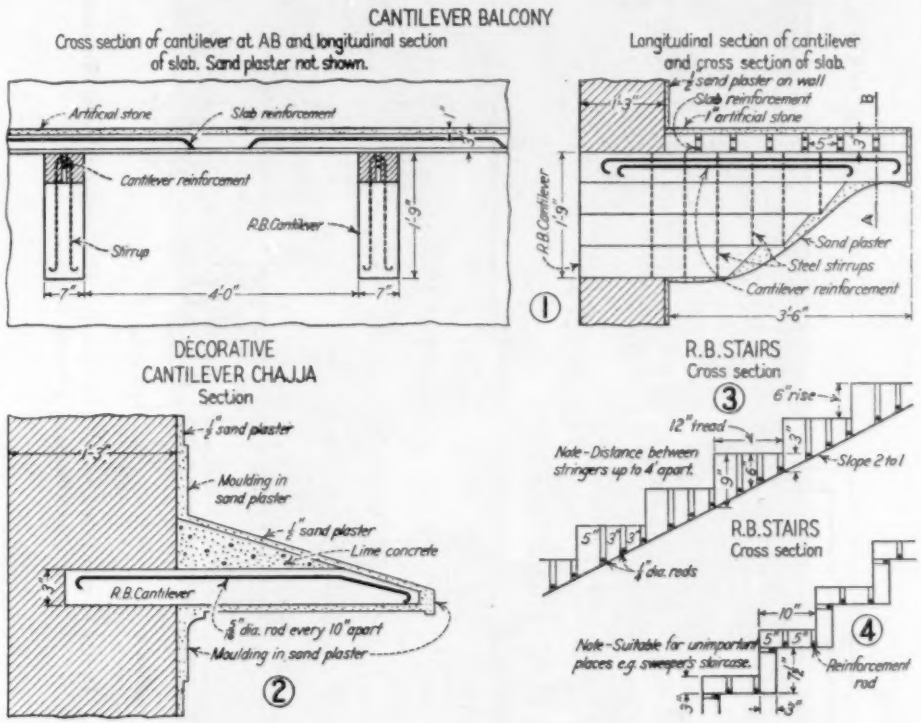


FIG. 2.—Reinforced brickwork. Typical Indian designs of stairs, cantilever chajja and balcony.

practical applications. This has already been done by Jones in North Carolina, Vogdes in Philadelphia, and Filippi in Chicago, and performance to date has been all or more than that expected.

It should be added that expanded metal reinforcement for brick masonry has been widely and successfully used in England. Reinforced curtain walls, only $4^1/_2$ inches thick between piers, are extensively used in industrial buildings.

II. Properties of Reinforced Brick Masonry

Reinforced brickwork, in all its essential properties, is practically the same as reinforced concrete. It is indeed handmade reinforced concrete.

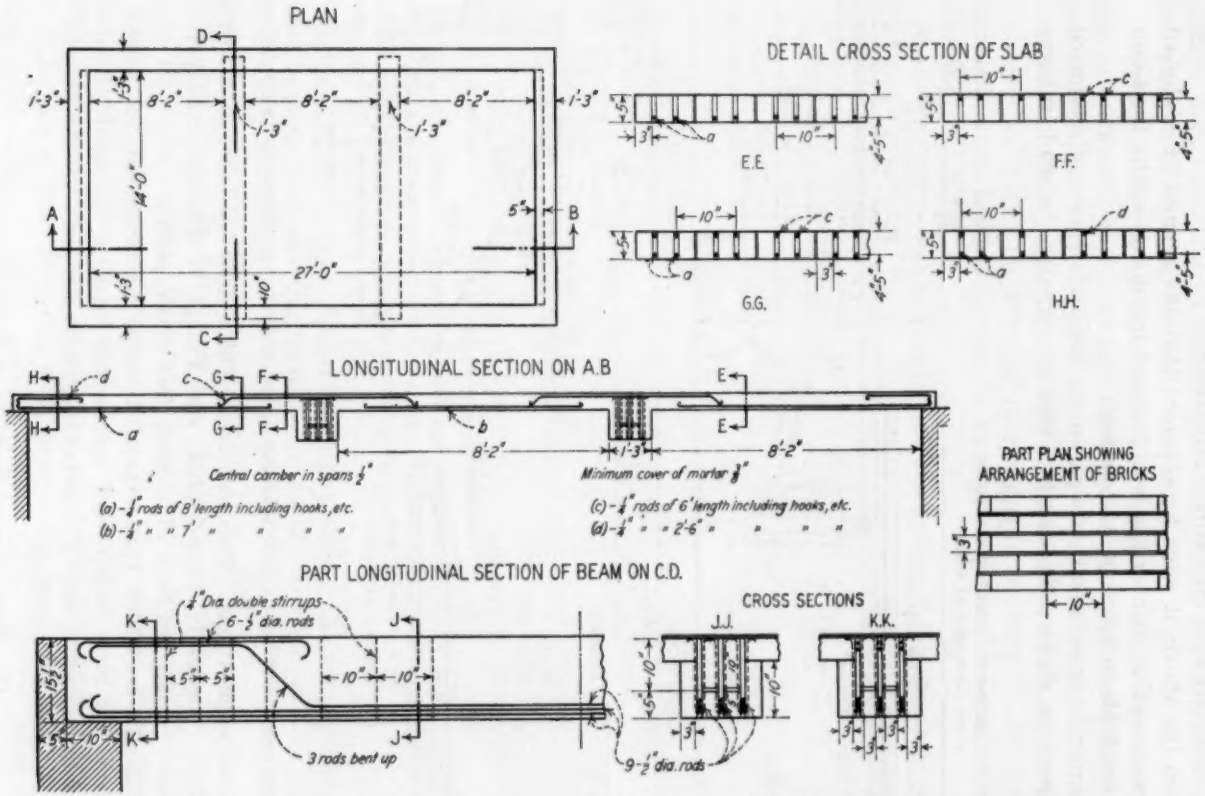

PLAN
DETAIL CROSS SECTION OF SLAB
E.E.
F.F.
G.G.
H.H.
LONGITUDINAL SECTION ON A.B
Central camber in spans ½"
Minimum cover of mortar ⅜"
(a) - ¼" rods of 8' length including hooks, etc.
(b) - ¼" " " 7' " " " "
(c) - ¼" rods of 6' length including hooks, etc.
(d) - ¼" " " 2'-6" " " "
PART PLAN SHOWING ARRANGEMENT OF BRICKS
PART LONGITUDINAL SECTION OF BEAM ON C.D.
¼" Dia. double stirrups
6 - ½" dia. rods
3 rods bent up
9 - ½" dia. rods
CROSS SECTIONS
J.J.
K.K.

FIG. 3.—Reinforced brickwork. Design of roof over a room 14 by 27 feet. Five-inch reinforced brickwork slab continuous over 2 intermediate T-beams (India).

in which the brick are the coarse aggregate and the mortar (cement and sand) is the fine aggregate with the steel placed by hand in the mortar joints.

The steel resists tensile stresses (and in some cases shearing stresses) and the brickwork resists compressive stresses.

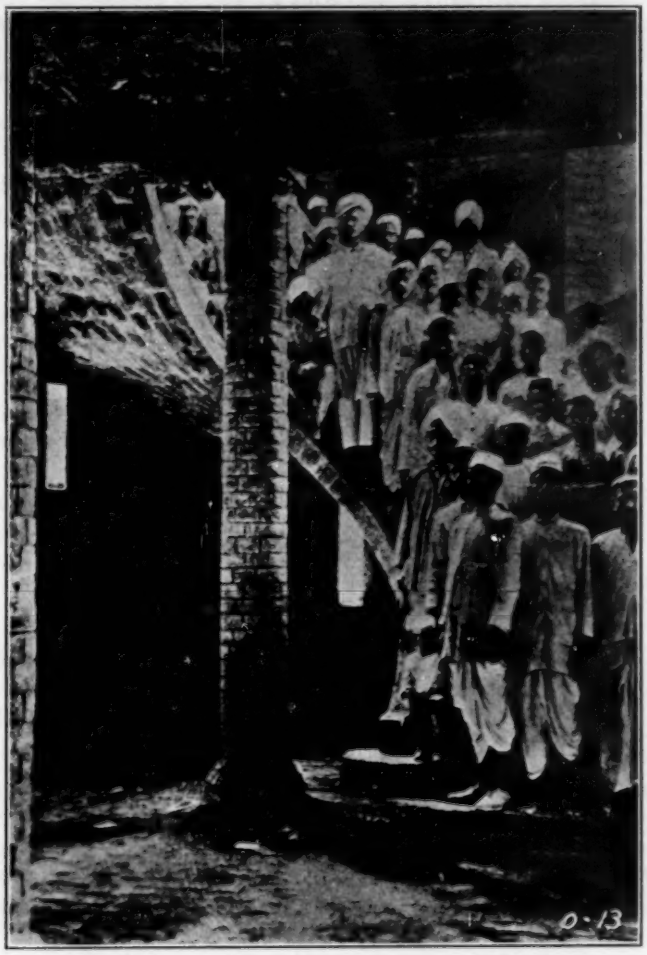


FIG. 4.—Reinforced brickwork spiral stairway, one brick thick (built in India).

It may seem to some that such construction would not act as a homogeneous mass, in that the mortar joints would constitute planes of weakness along which rupture might take place, but in practice this has been

found not to be true. On the contrary adhesion between brick and mortar and between mortar and steel is usually so great that failures (under test) are mostly failures of steel in tension.

A large number of tests have demonstrated that, for comparable constructions, reinforced brickwork and reinforced concrete have practically the same strength.

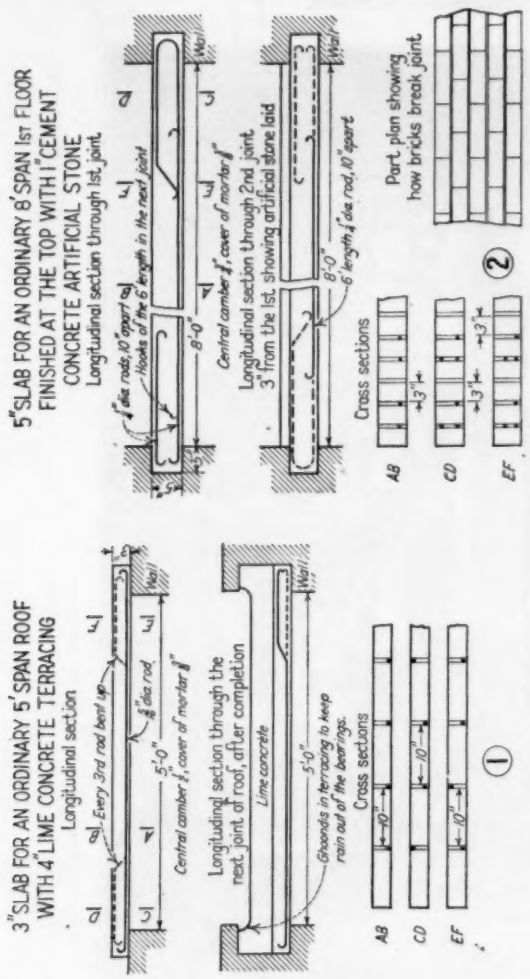

5"SLAB FOR AN ORDINARY 8'SPAN 1ST FLOOR
FINISHED AT THE TOP WITH 1'CEMENT
CONCRETE ARTIFICIAL STONE
Longitudinal section through 1st. joint.
Hooks of the 6' length in the next joint
Central camber 1", cover of mortar 1"
Longitudinal section through 2nd. joint
3" from the 1st. showing artificial stone laid
Part. plan showing how bricks break joint.
Cross sections
AB
CD
EF
3"SLAB FOR AN ORDINARY 5'SPAN ROOF
WITH 4'LIME CONCRETE TERRACING
Longitudinal section
Every 3rd rod bent up
Central camber 1", cover of mortar 1"
Longitudinal section through the next joint of roof, after completion
Lime concrete
Ghoonds in terracing to keep rain out of the bearings.
Cross sections
AB
CD
EF

FIG. 5.—Floor and roof slab design in India.

A detailed description of the several forms of reinforced brickwork would seem to be unnecessary, since the accompanying figures should serve this purpose.

Since only a few types are shown, it should be mentioned that this type of masonry has been built not only into simple beams and slabs, but into T-beams, cantilevers, columns, overhanging cornices, arches, retaining walls, abutments and wing walls, hanging partitions, bridge beams and decking, earthquake-resistant construction, and other minor types.

Most of these examples are to be found abroad, although a few have already been built here.

And the illustrations should also show how the reinforcement is placed so that the construction functions to resist bending forces.

III. Strength of Typical Forms

A presentation of test results of all forms of construction would require

pages of space and obviously must be omitted here. A few general values, however, derived from tests made in this country of some simple slabs and beams may serve to give the reader a more accurate idea of the performance of this kind of brick masonry.

The great effect of varying the span between supports must be kept in mind in any comparison of results, for bending moments are proportional to the squares of the spans.

(1) Vogdes Tests Vogdes[4] built and tested four beams, designed for use as lintels, at Philadelphia, Pa., in 1929. Two beams were 8 inches thick and six courses deep and two were 12 inches thick and six courses deep, as shown in Fig. 6. Cement mortar (1:3 mix)

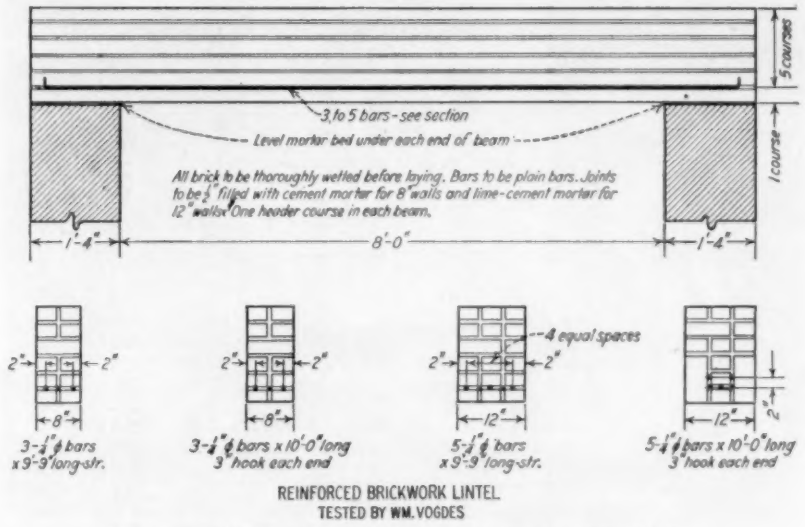

5 courses
1 course
3 to 5 bars - see section
Level mortar bed under each end of beam
All brick to be thoroughly wetted before laying. Bars to be plain bars. Joints to be ½" filled with cement mortar for 8" walls and lime-cement mortar for 12" walls. One header course in each beam.
1'-4"
8'-0"
1'-4"
2"
2"
8"
3-¼" ϕ bars x 9'-9" long-str.
3-¼" ϕ bars x 10'-0" long 3" hook each end
4 equal spaces
12"
5-¼" ϕ bars x 9'-9" long-str.
5-¼" ϕ bars x 10'-0" long 3" hook each end
REINFORCED BRICKWORK LINTEL
TESTED BY WM. VOGDES

FIG. 6.—Reinforced brickwork lintel, tested by Mr. Vogdes.

was used in the 8-inch beams and cement-lime mortar (1:1:6 mix) was used in the 12-inch beams. All were tested on an 8-foot clear span. The calculated load which these lintels would have to carry in ordinary brickwork was 1200 lb. for the 8-inch and 1800 lb. for the 12-inch beams.

Lintels were loaded at the $^1/_3$ points of the span. Test results were as follows:

Lintel No.	Design load (lb.)	Total load at first crack (lb.)	Total load at ultimate strength (lb.)
1	1200	5456	7564
2	1200	4945	7480
3	1800	8075	10720
4	1800	7825	13000

[4] Judson Vogdes, Engineer, Common Brick Mfrs. Assn., Philadelphia, Pa.

It may be seen that these lintels possessed a safety factor of more than 4, based upon the design loads and calculated from loads at "first crack." If ultimate strength values were used in the calculation of the safety factor, this factor would be much higher.

Space does not permit of a more extended description of these experiments.

(2) Filippi Tests

Filippi,[5] in Chicago, Ill., tested 10 beams and 12 slabs and obtained interesting and instructive results, the essential ones being given in Table I.

The first four beams were built without reinforcement, the others with

TABLE I

COMPARATIVE DATA ON REINFORCED BRICKWORK BEAMS AND SLABS

Mark	Kind	Mortar[a]	Reinforcement Number[c]	Size (inches)	Age (days) when tested	Span (ft.)	Max. live load (lb.)	Max. ♯ unit live load (lb.)	Max. deflection (inches)
PB 1	Beam	1–1–6	None		24	10	574	57	1/32
" 2	"	1–1–6	"				(1)		
" 3	"	1–1–6	"		26		410	41	1/32
" 4	"	1–0.15–3	"		25		240	24	
RB 1	"	1–1–6	3	3/8	23	10	2500*	250	11/32
" 2	"	1–1–6	"	"	26	"	3978	398	3/16
" 3	"	1–1–6	"	"	28	"	3332	333	1/8
" 4	"	1–0.15–3	"	"	22	"	4000	400	1/4
" 5	"	1–0.15–3	"	"	25	"	7500	750	7/16
" 6	"	1–0.15–3	"	"	27	"	6500	650	13/32
FS 1	Slab	1–1–6	6	1/4	18	5	3724	298	1/2
" 2	"	1–1–6	"	"	20	"	4220	338	9/16
" 3	"	1–1–6	"	"	20	"	3797	304	19/32
" 4	"	1–0.15–3	"	"	21	"	3390	271	5/8
" 5	"	1–0.15–3	"	"	21	"	3500	280	9/16
" 6	"	1–0.15–3	"	"	21	"	3750	300	17/32
RS 1	"	1–1–6	6	3/8	19	8	6254	276	15/16
" 2	"	1–1–6	"	"	24	"	6206	274	11/16
" 3	"	1–1–6	"	"	21	"	7500	331	1
" 4	"	1–0.15–3	"	"	24	"	8500	375	1 1/8
" 5	"	1–0.15–3	"	"	24	"	8372	370	7/8
" 6	"	1–0.15–3	"	"	24	"	9000	397	29/32

* Cracked in handling to test platform.
♯ Per linear foot for beams and per square foot for slabs.
[a] 1–1–6 means 1 part Portland cement, 1 part lime, and 6 parts sand.
1–0.15–3 means 1 Portland cement, 15% lime, and 3 parts sand.
[c] Only round bars used; 3/8-in. bars were corrugated and 1/4-in. bars were plain.

reinforcement as indicated. The beams were 8 inches wide and 13 3/8 inches deep (5 courses of brick flat) and tested on 10-foot spans. Six slabs were built of brick laid flat (2 1/4 inches thick by 30 inches wide) and tested on 5-foot spans; and six slabs were built with brick on edge (3 3/4 inches thick by 34 inches wide) and tested on 8-foot spans.

[5] Engineer, Common Brick Mfrs. Assn., Chicago, Ill.

The number and size of reinforcing rods, the kind of mortar, and the age of specimens are given in Table I. (See Figs. 7 and 8.)

In the beams, reinforcement was placed in the lowest mortar joint (just above the lowest course of brickwork) and in the slabs, reinforcing rods were so placed as to have about $^1/_2$-inch mortar cover at the bottom of the slabs.

It is quite evident that strengths developed were such as to make these beams and slabs amply strong for use in many places in actual structures,

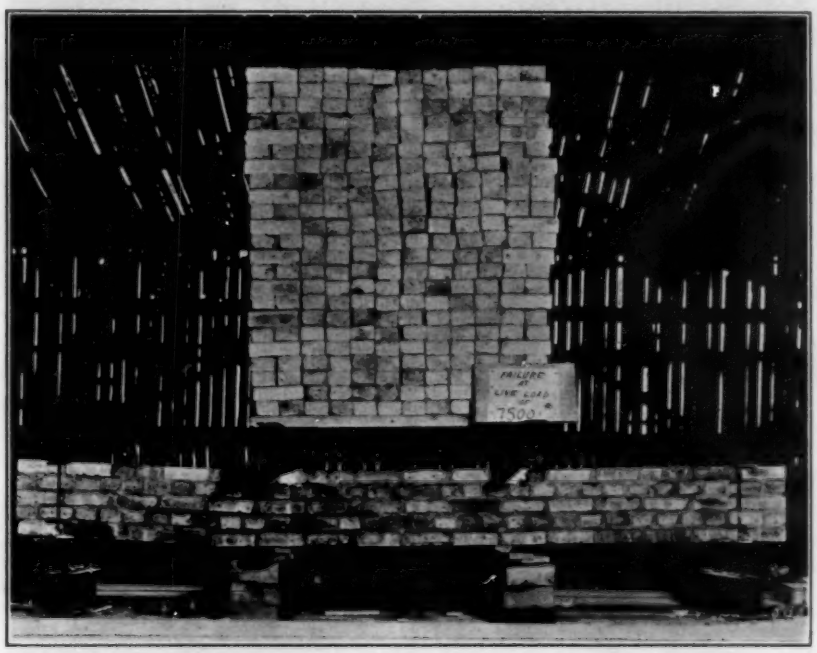


FIG. 7.—Filippi's tests: reinforced brickwork beam. 7500 lb. on 10-ft. span.

especially when deflection measurements showed that allowable deflections of 1/360 of the spans were produced by loads much above the design loadings.

IV. Experiments by the Author

In order to study the value of metal mesh as reinforcement, and also to study the performance of precast slabs in commercial work, the author built several slabs at the Cleveland Trade School and tested several in January, 1931. In England, metal mesh, made for the purpose, has been widely and successfully used for reinforcing brickwork.

Both Truscon light-weight $^3/_8$-inch "Hy-rib" and $^1/_4$-inch rods were

used as reinforcement in slabs built of brick laid flat ($2^1/_4$ inches deep). The metal mesh was placed on the bottom of the slabs and embedded in mortar. Cement-lime mortar (1 : 1 : 6 mix) was used.

These experiments are not yet complete and a full report is not available, but some interesting results were obtained.

Most tests were made on 4-foot spans, as representing a common

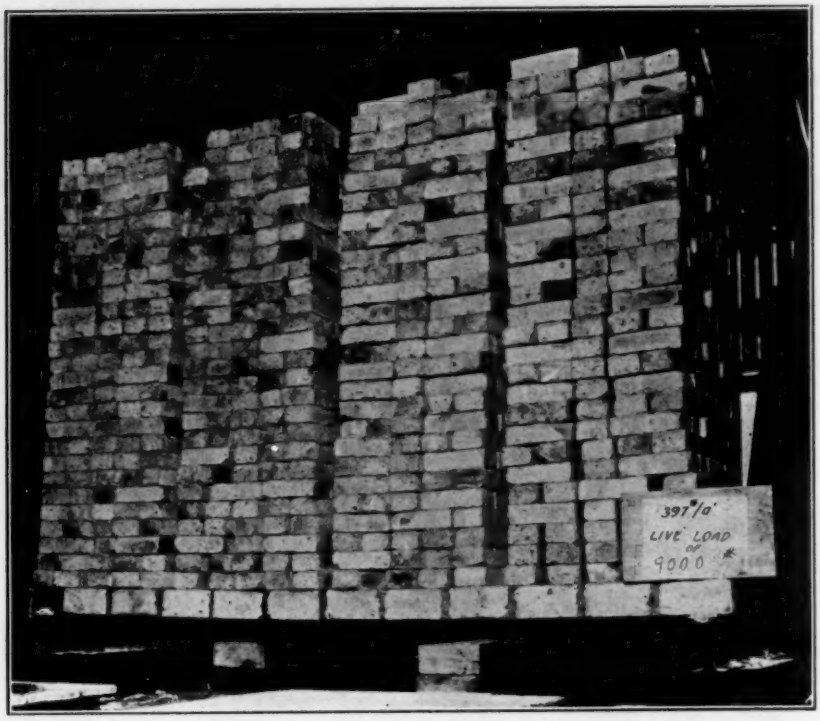


FIG. 8.—Filippi's tests: reinforced slab. Brick on edge. 9000 lb. on 8-foot span.

spacing of steel floor beams. In order to study the limiting dimensions of span, one test has been made on a 7-foot span.

Slab "A," built with brick laid flat and reinforced with 4-lb. diamond-mesh "Hy-rib" at the bottom, required a uniform load of 475 lb. per sq. ft. to produce an allowable deflection of 1/360 of the span ($^1/_8$-inch +).

Slab "C," having the same dimensions as slab "A," but reinforced with $^1/_4$-inch rod in each mortar joint, required a uniform load of 350 lb. per sq. ft. to produce an allowable deflection of $^1/_8$ inch.

The greater strength developed by slab "A," built with wire mesh on

the bottom, is caused no doubt because it had more reinforcing steel and a greater effective depth.

Slab "D" was similar to slab "C," except that the brick were laid in regular pattern instead of having broken transverse joints. We hoped to find out whether or not broken or unbroken brickwork joints had an appreciable effect.

This slab took a uniform load of 156 lb. per sq. ft. to produce the

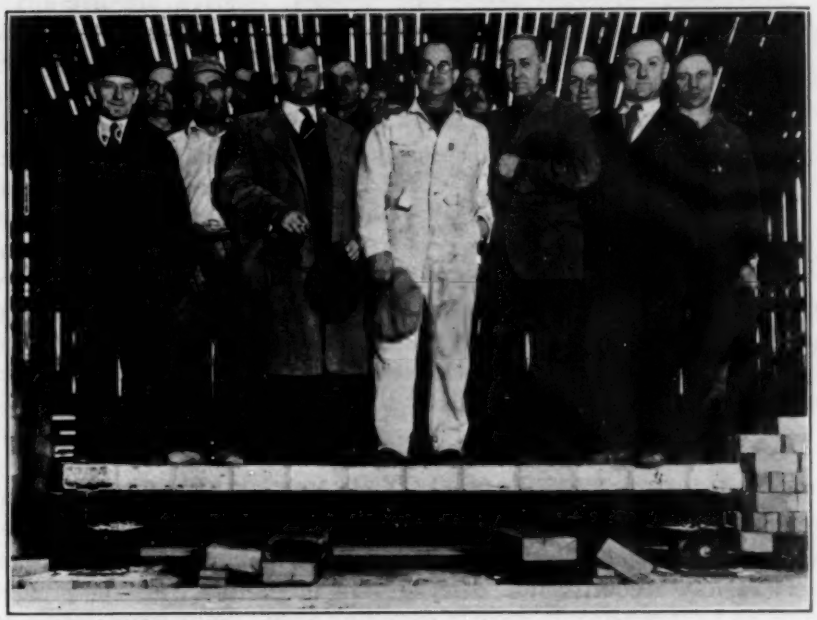


FIG. 9.—R. B. tests, Chicago, Ill., November, 1930. $2^1/_4$-inch slab. 2280-pound "live" load. No appreciable deflection.

allowable deflection, and required 425 lb. per sq. ft. before failure occurred.

It seemed at first that the manner of arranging brick had a definite effect on strength, but upon breaking up both slabs after test we discovered that the reinforcement in the weaker slab was not near the bottom, but that 4 out of 5 rods were nearer the neutral axis than the bottom, thus materially reducing the effective depth of this slab. This would easily account for its lower (comparative) strength.

To explore the bending strength under larger spans, slab "F," $15^3/_4$ by 84 inches, was tested on a 7-foot span. This slab was reinforced with diamond mesh at the bottom and was about 3 inches deep.

Allowable deflection was reached under a load of 50 lb. per sq. ft.

and the slab failed by cracking through at mid-span under a total load of 705 lb. (62.5 lb. per sq. ft.).

It is evident that such a slab should not be used on this long span (7 feet), except under very light loads, or not at all.

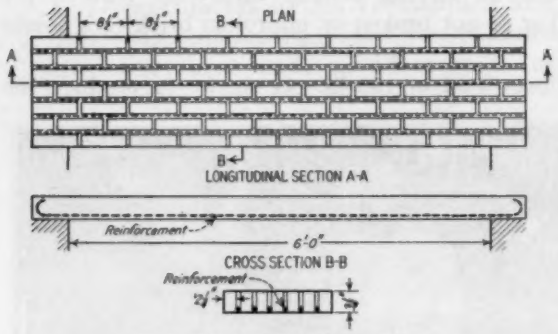


FIG. 10.

All loads previously given are live loads and do not include the weight of the respective slabs.

It is also evident that on the shorter spans, about 4 feet, both types of slabs, *i.e.*, "Hy-rib" and 1/4-inch rods are amply strong for fairly heavy floor loads, 100 lb. per sq. ft., at least, and perhaps up to 250 lb. per sq. ft. or more.

Such a joist spacing (4 ft.) is a conventional one and builds into an economical system of floor framing.

V. Commercial Applications of Reinforced Brick Masonry

There has not been any extensive use of this construction in this country. This is not indicative of any merit or demerit, for once our designers have the necessary information in hand, a usage may be developed very rapidly if construction costs are not prohibitive. At the present time we have practically no data regarding costs. Such estimates as we can make indicate that certain forms of reinforced brickwork may cost even less than these same forms built of other materials.

It may be that many kinds of slabs and beams may be precast and later put into their proper place in the structure and that such precast forms of brickwork will be entirely free of the defects common to some other forms of precast masonry.

To clarify that statement, we should remember that mortar joints and pattern work (regular or otherwise) make up a brickwork slab, so that when two or more precast slabs are fitted together the joints match up to make the pattern continuous over the larger area and the mortar joints divide the pattern.

Thus there need be no unsightly joints or cracks where slabs are joined together, as there often is in reinforced concrete. In fact, many of the objections found in the use of precast units of reinforced concrete disappear in reinforced brickwork. For example, in floor slabs, there would

be no difficulty whatever in leaving top mortar joints partly filled at the slab ends and so permit short top reinforcing rods to be laid into adjacent slabs over the joist supports thus supplying ample reinforcement to resist the negative bending moment over joists and beams. This, of course, is most difficult and nearly impossible in the case of precast concrete slabs.

The joints in reinforced brickwork are, in fact, a distinct advantage in many respects.

Therefore, if we disregard cost for the moment, many practical applications of reinforced brickwork suggest themselves, a few of which are window lintels and sills, floor slabs and roof slabs, columns and curtain walls, cantilever beams and cornices, porch floors and stairs, all forms of retaining walls, storage structures (especially of circular plan), and all kinds of spandrel beams.

A combination of brickwork columns (with or without reinforcement), spandrel beams, and apron walls should produce an outer or inner wall of an industrial or commercial building which is, at once, amply strong, highly fire-resistant, of pleasing appearance, and should cost as little or less than any other kind of masonry or combination structure.

Space does not permit of an extended discussion of the possibilities of reinforced brick masonry. Suffice it to say that they are numerous and inviting. They should command our studious attention.

VI. Information Yet to Be Obtained

Before we can confidently recommend this type of construction and have its use readily accepted, we must have more information of two kinds, *viz.*, (1) the possible difficulties of its application in all types of structures under existing conditions and (2) cost information.

Obviously neither of these may be obtained in the laboratory. Field experience alone can furnish this type of data.

Already several examples have been completed, consisting essentially of window lintels and other beams, porch floors, a few slabs, and the abutments and wing walls of a highway underpass.

There are also other instances of reinforced brickwork which are now several years old, consisting principally of retaining walls and similar structures.

The present interest in this type of masonry will not wane, as it apparently did in the past, but will be sustained and enlarged until reinforced brick masonry becomes a most useful aid to the solution of many of our design problems.

2121 Guarantee Title Bldg.
Cleveland, Ohio

EFFECTS OF BODY COMPOSITION AND FIRING TREATMENT ON SALT GLAZES[1]

By R. K. Hursh and E. C. Clemens

ABSTRACT

Five synthetic bodies were made up in which the silica, alumina, ferric oxide, and alkalis were varied. Salts were added to these bodies in various amounts; the bodies were dried and fired under carefully controlled conditions and salt glazed under oxidizing conditions at cones 2, 5, and 7 and under reducing conditions at cone 5. The effects of body composition and glazing temperature on the appearance of the bodies are given. Reducing conditions during glazing increased the glaze thickness. The maturity of the glaze is more important than the thickness. Devitrification of the glazes is more important than the presence of impurities. Crystals of hematite, acmite, nephelite, and carnegieite were found in the glazes. Firing treatment has a greater influence on glaze character than chemical composition.

I. Introduction

This study was undertaken to determine the influence of the body composition, the action of impurities at the surface to be glazed, and the effects of different firing treatments on the properties and nature of glazes formed on the body.

Note: Reference is made to literature as follows:
(1) An Encyclopedia of the Ceramic Industries (Q–Z), p. 83.
(2) *Jour. Amer. Ceram. Soc.*, **6**, 717–29 (1923); *ibid.*, **7**, 411–22, 539–47 (1924).
(3) *Sprechsaal*, **60**, 294–97, 314–17, 331–34, 349–52 (1927); *ibid.*, **62**, M 36, 37, 42, 43, 47, 48 (1929).
(4) *Keram. Rund.*, **36**, 765–67 (1928).

II. General Plan of Investigation

This investigation was planned to determine the influence on the nature of the glaze of the following variables:

(1) The effect of varying the SiO_2, Al_2O_3, Fe_2O_3, and KNaO in the body composition.
(2) The effect of additions of $CaSO_4$, Na_2SO_4, $MgSO_4$, $BaCO_3$, $BaCl_2$, Na_2CO_3, Na_2SiO_3, NaCl, $CaCO_3$, FeS_2, and $MgCO_3$.
(3) The effect of oxidizing and reducing atmospheres during salting.
(4) The effect of firing temperature.
(5) The effect of porosity of the body.

From the chemical compositions of a number of bodies used in the manufacture of salt-glazed ware, an average body composition was selected. Synthetic bodies were prepared in which the contents of silica, alumina, iron oxide, and alkalis were varied. To each of these mixtures, salts which

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Structural Clay Products Division). Received February 3, 1931.

The data in this paper is from a thesis submitted by E. C. Clemens in partial fulfilment of the requirements for the degree of Master of Science in Ceramic Engineering at the University of Illinois, February, 1931.

normally occur as impurities in clays were added in different percentages up to the maximum amounts found naturally in clays. The bodies were dried under conditions which allowed slow evaporation and a deposition of the maximum amount of soluble material on the surface of the specimen. They were fired under carefully controlled and reproducible heat treatments and atmospheric conditions.

After firing, the glazes were examined with a binocular microscope to determine their structural character. Thin sections were made of a number of the glazes, including all of those which were opaque. Porosity determinations were made on five bodies in which the composition was varied in respect to silica, alumina, ferric oxide, and alkalis, but which were untreated by additions of salts to determine the relationship of this property and the character of the glazes formed on the bodies. These bodies were fired under oxidizing conditions and a devitrification study was made to determine the lowest temperature at which crystals formed or grew in the glaze and the identity of the crystals.

III. Experimental Procedure

Each specimen was heated for five hours at a constant temperature in a platinum resistance furnace, air-quenched, and examined for crystals. This was repeated at increasing temperatures until crystal growth was noted. A variation of 25°F in temperature during the heating period resulted from faulty operation of the automatic voltage regulator.

Another set of specimens was heated at 1800°F for 24 hours and the minerals formed were determined.

Porosity determinations were made by the displacement method.

IV. Body Compositions

The compositions of the bodies used in this investigation are given in Table I.

TABLE I

Chemical	A	B	C	D	E
SiO_2	75.0	67.0	60.0	66.0	67.0
Al_2O_3	18.0	26.0	33.0	24.0	24.0
Fe_2O_3	5.5	5.5	5.5	8.5	5.5
KNaO	1.5	1.5	1.5	1.5	3.5
SiO_2/Al_2O_3	4.17	2.57	1.81	2.74	2.78
Al_2O_3/SiO_2	0.24	0.38	0.55	0.36	0.35
Batch					
Feldspar	10.2	9.8	9.8	9.6	23.1
Fla. kaolin	17.7	26.0	32.8	23.2	20.9
N. C. kaolin	17.9	26.3	33.1	23.4	21.1
SiO_2	42.8	27.1	13.7	27.3	23.5
Ferric oxalate	11.3	11.0	10.7	16.5	11.2

Body "B" represents the average chemical composition of 40 sewerpipe bodies which were used in commercial salt glazing. This body was used for a standard of comparison for the other bodies.

Mixtures were made up in 25-gram portions of each of the above bodies and with each of the following additions of salts:

Calcium sulphate	0.2%	0.4%	0.6%	0.8%	1.0%
Magnesium sulphate	"	"	"	"	"
Sodium sulphate	"	"	"	"	"
Barium carbonate	"	0.5	1.0		
Barium chloride	"	"	"		
Sodium carbonate	0.1	0.2	0.25		
" silicate	"	"	"		
" chloride	"	"	"		
Calcium carbonate	2.0	3.0	4.0		
Pyrites (FeS_2)	1.0	2.0	3.0		
Magnesium carbonate	2.0	3.0	4.0		

A sample of each untreated body was used for comparison with the mixtures in which the salt additions had been made to that body. In addition, a sample of a commercial body which was known to salt glaze well was fired and glazed with each set of specimens.

V. Results

(1) Appearance of Dried Bodies In general, the additions of the above salts to the specimens caused scumming or discoloration of the surfaces after the specimens were thoroughly dried. This was very noticeable after heating to 1000°F. The specimens containing pyrites were not scummed but were darker in color than the untreated bodies.

(2) Effect of Oxidizing during Glazing The appearance of the various bodies fired to cone 5 and glazed under oxidizing conditions was as follows:

Body "B," which represented the average composition of commercial bodies, was gray-brown and covered with a medium brown glaze of good gloss and eggshell texture. The salt additions had no appreciable effect except where magnesium carbonate was added. This caused a green-brown glaze to form.

Body "A," with high silica content, was dark red and covered with a dark red-brown glaze of good gloss with an eggshell texture. The salt additions had no appreciable effect except in the case of magnesium carbonate. This caused a green-brown glaze to form.

Body "C," high in alumina, was gray and covered with a dirty light brown glaze of semimat character and an eggshell texture more pronounced than with any of the other bodies. The only salt additions which caused any change were calcium carbonate which gave the glaze a darker brown color, and magnesium carbonate which also caused a dark brown color. Both of these salts caused a mat glaze to form.

Body "D," with the highest iron oxide content, was dark red and covered with a dark red-brown glaze of good gloss and eggshell texture. The only

salt addition which caused any change was magnesium carbonate which gave a green-brown color to the glaze.

Body "E," with the highest alkali content, was medium red-brown and covered with a medium red-brown glaze of good gloss and eggshell texture. Magnesium carbonate, the only salt addition to cause an appreciable change formed a semimat green-brown glaze.

The color and mat effect caused by magnesium carbonate was only slightly noticeable with additions of 1.0% to the body, but with each increase of 1.0% the darkening of the body color and increased matness of the glaze were quite prominent.

The commercial body took good uniform red-brown glaze.

(3) Effect of Firing Temperature The original untreated bodies and the bodies treated with 1% calcium sulphate or sodium sulphate, when fired under oxidizing conditions to cone 2 and salted, gave immature glazes. The addition of 4% of calcium carbonate or magnesium carbonate caused the glaze to have a good gloss. The magnesium carbonate also produced a green color in the glaze.

Specimens of the same mixture were also fired and salt glazed at cone 7. These gave the same results in appearance as those fired to cone 5.

(4) Effect of Reducing Conditions Specimens of the mixtures were fired to cone 5 and salt glazed in an atmosphere containing 1 to 2% carbon monoxide. These gave results as follows:

Body "A," with the highest SiO_2 content, was dark red and covered with a dark red glaze, with patches of a gray-green color. The gloss was good and the texture smooth.

Magnesium carbonate was the only salt addition causing any change from the above appearance. It caused a dark green color.

Body "B," the average composition, was light brown and covered with a light brown glaze, with some gray-green spots. It had a good gloss and an eggshell texture. Calcium and magnesium carbonates, the only salt additions causing any change in appearance, changed the color to a greenish-brown.

Body "C," with high alumina, was gray-brown and covered with a gray-brown glaze of mat appearance and eggshell texture. Salt additions caused no change.

Body "D," with high iron oxide, was of deep red-brown color and covered with a dark brown glaze of good gloss and eggshell texture. In places the glaze was gray-green. Magnesium carbonate was the only salt addition to cause any change, producing a mat surface on the glaze.

Body "E," high in alkalis, was light brown and covered with a light brown glaze, colored gray-green in spots. The glaze had a good gloss and an eggshell texture. Magnesium carbonate, the only salt addition to cause any change, formed a green-brown glaze.

As in the case of glazes formed under oxidizing conditions, the effects of magnesium and calcium carbonates increased with the amount added.

The commercial body was covered with a good uniform greenish-brown glaze.

In the bodies highest in alumina the eggshell texture seemed to be more pronounced than in the other bodies.

(5) Glaze Thickness The glaze thicknesses on all bodies fired to cone 5 and glazed under reducing conditions is, in nearly every case, greater than on those formed under oxidizing conditions. There is not a consistent relation between the addition of salts to the body and the thickness of the glaze except in the case of magnesium carbonate and calcium carbonate which produced glazes of greater thickness than on the untreated body. The glaze thickness with various salt additions and under oxidizing and reducing conditions seems to be more uniform on high alumina bodies than on the other bodies.

The glaze thicknesses on bodies fired under oxidizing conditions at higher temperatures were in general increased, but not uniformly in proportion to the increased temperature.

(6) Character of Glazes All of the glazes were crazed. The bodies containing pyrites showed solution pits where the pyrites had been removed.

Small black irregular particles suspended in the glazes were noted on the bodies fired to cone 5 and glazed under reducing conditions. These were not crystalline but appeared to be particles of suspended carbon. In some cases it was present in amounts great enough to cause the color of the glaze to be very dark.

The glazes containing magnesium carbonate had occasional dull spots on their surfaces and, in one or two cases, this was extensive enough to cause a distinct dullness over the whole specimen. In this section these dull spots did not appear crystalline, but had the appearance of a dark brown glass with a very irregular surface. The spots may have been due to cryptocrystalline hematite but this could not be verified. This phenomenon was noted also in some of the glazes which were formed on bodies containing calcium carbonate.

Crystals of carnegieite or nephelite are formed in nearly all the glazes on high alumina bodies. These two crystals have the same chemical compositions but different stability relations. Of the bodies glazed under reducing conditions, carnegieite is found in the glaze on the average body "B," in the mixture containing 4% calcium carbonate, and nephelite occurs where 4% magnesium carbonate was added.

In the glaze formed on the high alkali body "E," under oxidizing conditions, nephelite occurs where 4% magnesium carbonate has been added. The occurrence of hematite in glazes on bodies high in alkalis or high in

silica is rare. It occurs in glazes on bodies highest in alumina and iron oxide. In some cases the crystals were more nearly perfect than in others. The addition of salts does not seem to have a uniform effect on the crystallization of the glaze or the perfection of crystal growth.

(7) Porosity The results of porosity determinations made upon the five untreated bodies fired and salt glazed under identical oxidizing conditions and the thickness of glazes formed on these are given in Table II.

TABLE II

Property Cone 5	Porosity (%)	Glaze thickness (in. × 10^{-3})	Minimum temp. of heating at which crystals grow in glaze in 5 hrs. 25°F	Crystals formed in glaze at 1800°F in 24 hrs.
A	20.5	0.298	2000	Hematite Acmite
B	17.2	0.290	1800	Acmite
C	14.7	0.295	1570	Acmite Carnegieite
D	16.5	0.298	1630	Hematite Acmite
E	13.2	0.250	1850	Hematite Acmite
Commercial			1450	Acmite

Compared with the average body composition "B," the porosity increased with an increase in free silica in the body and decreased with an increase in feldspar. The increase of iron oxide lowered the porosity a slight amount. The glaze thickness was fairly uniform for all the bodies. The increase in free silica should increase the glaze thickness on the body but this effect is counteracted by the effect of increased porosity. The increase in feldspar increases the density of the body and the reaction of the salt with the body is less rapid.

(8) Devitrification The minimum temperatures at which crystals form in the glazes on the bodies fired to cone 5 under oxidizing conditions and the identity of these crystals is given in Table II. An increase in silica increases the devitrification temperature. The glazes on bodies highest in iron oxide and alumina crystallizes at the lowest temperatures. An increase in the flux content of the body raises the temperature of crystallization. The glaze formed on a commercial body under the same firing conditions devitrified at a lower temperature than any of those on a synthetic body. Hematite and acmite formed in the glaze on body "A," highest in silica; acmite on body "B," the average body; acmite and carnegieite on body "C," high in alumina; hematite and acmite on body "D," high in iron oxide; hematite and acmite on body "E," high in alkalis; and only acmite on the commercial body. The relative quantities of the crystals formed could not be estimated, but in all cases the crystals were well grown. All of the crystals grew both from the body into the

glaze and suspended in the glaze, except hematite which appeared only as suspended in the glaze.

VI. Summary of Results

In general, the following conclusions can be drawn from this investigation:

(1) The presence of small amounts of salts as impurities in the synthetic bodies had no appreciable effect, except where calcium and magnesium carbonate were added. Above 1.0% of either salt in a body to be glazed is not advisable.

(2) The presence of these salts as impurities in the body may cause a surface discoloration or "scumming" on drying but they should decompose before the glazing temperature is reached.

(3) Dulling and discoloration of the salt glaze are probably due to other conditions than the presence of impurities. Devitrification is probably the most prominent cause of dull and mat glazes. This, of course, may be aided by impurities which change the viscosity relations of the glass.

(4) An increase in alumina, at the expense of silica, above that of the average body composition lightened the color of the body, reduced the gloss, and caused an increase in the tendency to form an eggshell texture. It also increased the tendency of the glaze to devitrify.

(5) An increase in silica at the expense of alumina increased the gloss and improved the color and texture. It decreased the tendency to crystallize.

(6) An increase in iron oxide at the expense of both alumina and silica seemed to cause little change in appearance except a darkening of the color. It increased the tendency to crystallize.

(7) A slight increase in the flux content at the expense of the alumina and silica content seemed to cause little change in appearance. The tendency to crystallize was decreased.

(8) Reducing conditions during the salt-glazing period increased the thickness of the glazes over those formed by salting under oxidizing conditions. These glazes were darker than those formed under oxidizing conditions except in the high alumina body. The darker color is due either to surface reduction of the body or to the deposition of carbon. The green spots in the glazes are due to the color of the body in which a ferrous glass has been formed. In the glaze on the high alumina body the lighter color is due to devitrification of the glaze. More and better formed crystals are found in the glazes formed under reducing conditions. These facts indicate that these glazes were more fluid than those formed under oxidizing conditions.

(9) The salt additions to the bodies seem to have little effect on the firing range, except in the case of magnesium and calcium carbonate. At cone 2 these salts aid the maturing of the glaze while the other glazes at this temperature were immature.

(10) Since a glaze of measurable thickness was developed on all the mixtures, the influence of variable compositions and firing conditions in this respect are not important within the range studied. In some cases the glazes appeared immature, while slightly overfired in other cases. It is

probable that glaze thickness is somewhat affected by the porosity of the body but the data is not sufficient to confirm this.

(11) The firing treatment is of greater importance than the body composition in the effect on salt glazes. Firing treatment controls the porosity of the body, the maturity of the body and glazes, and the viscosity of the glaze which, in turn, is one controlling factor in the tendency of the glaze to crystallize.

SODIUM SILICATE, A NEW ENAMEL RAW MATERIAL[1]

By M. E. Manson

ABSTRACT

The addition of silica to enamel in the form of a readily fusible silicate, such as sodium silicate, lowers the smelting time and temperature required to bring about complete solution of the silica. Enamels in which all the silica was introduced in the form of quartz, although apparently completely smelted, still contained large quantities of free silica, while enamels of identical analysis in which sodium silicate was the sole source of silica contained, after smelting, no free silica. The presence of this free silica in an enamel affects its workability and acid resistance.

I. Introduction

A few years ago, an acid-proof white enamel, resistant to fruit acids and in appearance as good as the soft enamels then in use for enameled sanitary ware, was announced. Many companies planned research for a formula for such an enamel.

The literature on acid-proof enamel was contradictory. It was agreed by all that a large amount of silica was essential in such an enamel.

Several enamels of high silica content were uniformly too refractory to give smooth pieces and yet were not acid-proof.

It seemed possible that while there might have been enough silica present to give a glass of 60% SiO_2, under the conditions of smelting, this silica was not all combined, giving as a final product a glass of lower silica content with a considerable amount of free silica suspended in it.

II. Trial Studies

A plate enameled with a 60% SiO_2 enamel, but which was not acid-proof, was kept in a furnace at 1100°F for sixteen hours to dissolve any free silica present, thus raising the content of combined silica. This actually seemed to happen; at least, the plate after this treatment was much more acid-resisting.

The problem appeared to be to get the requisite amount of silica actually into solution.

Starting with a soft enamel, quartz, antimony oxide, and soda were added and an enamel of the requisite coefficient of expansion and opacifier content, but containing 50% SiO_2, was developed.

The first smelt came out of the crucible a beautiful opaque white. It worked fairly softly and was unmarked by either 10% citric acid or 1:1 hydrochloric acid. An enamel of the same analysis, but starting with all raw materials, had a poor appearance and was not acid-proof.

A plant trial was made in a rotary oil-fired smelter. If the optical py-

---

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio (Enamel Division). Received March 14, 1931.

rometer was to be believed, it was very difficult to attain a temperature of over 2000°F in this smelter.

The enamel obtained with a soft frit was used in the production of acid-resisting ware.

One smelt calculated to have the exact composition as that made with soft frit but in which all of the silica was introduced as feldspar and quartz was nearly unworkable and not acid-resisting. A cone fusion test of these two enamels gave identical results. The two cones came down as one.

Several foreign formulas for supposedly acid-proof enamels called for large quantities of ground glass. Their good results with these formulas may have been due to addition of fusible silica in glass cullet. Sodium silicate appeared to be the most easily available and uniform substitute for glass cullet. Powdered silicate of soda was available, having a composition of approximately 76% SiO_2, 23% Na_2O, the remainder being water and impurities; its fusion point was about 850°F. Its cost is about $3^1/_2$ cents per pound.

Just as good results were obtained with sodium silicate as with soft enamel as a batch material. Since soda was the only flux introduced by it, the flux content of enamel could be varied at will. Not only could acid-proof enamel be made in this way, but a regular production enamel was also made which contained about 10% more silica than the former soft enamel. This enamel was nearly as soft as the former, so that very little production was lost. Yet this latter formula, when made from feldspar and quartz, was very refractory.

It was decided, therefore, that sodium silicate was of great help in making hard enamels, but no actual data, photographs, or figures were available to prove this. No differences could be observed in cone fusion tests between enamel made from sodium silicate and quartz. There was a difference in acid resistance, and the dusters who applied the enamel to the ware could detect the difference in hardness or workability. Others who tried the material could see no benefit.

New data have since been obtained which explain some of the inconsistent results obtained by other investigators.

In the meantime a new tool had been developed by the Electric Porcelain & Mfg. Co., of Trenton, N. J., in a patented fusion test block. See Fig. 1.

FIG. 1.

NOTE: In this block, the keystone-shaped recess at the top is packed tightly with moistened enamel powder and dried. When a group of these, filled with different enamels, are put into a uniformly heated furnace, the length to which the enamel runs down the inclined face of the block is a measure of its workability in dry-process enameling. The result of the cone fusion

test is of very little value in predicting the performance of a dry-process enamel, but this block which probably measures the combined effect of fusibility and viscosity, approximates fairly closely the conditions of enameling.

III. The Final Study

A series of acid-proof enamels were made up, each formula made with and without sodium silicate. These enamels were smelted in a crucible to a quiet fusion. None of the batches gave difficulty in smelting. They were poured into water, dried, ground to the same degree of fineness, and

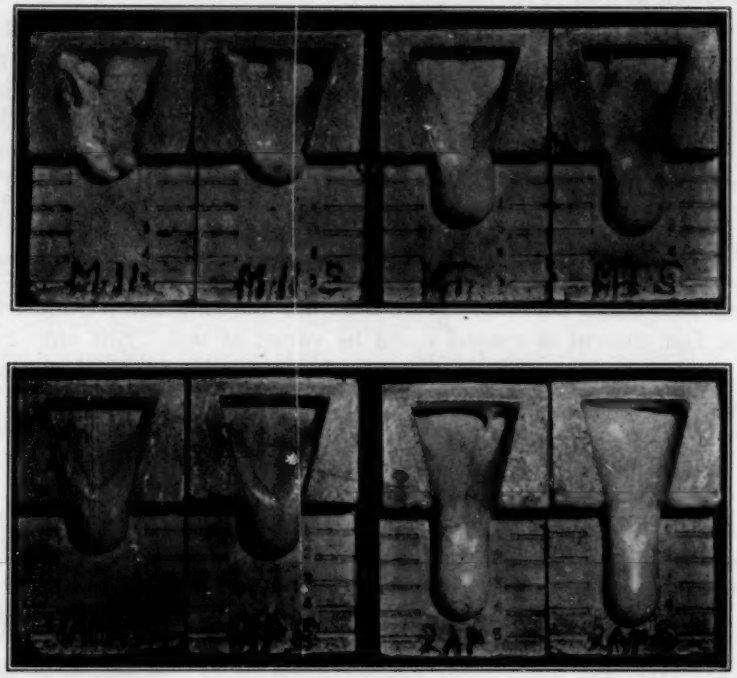


FIG. 2.

sample plates enameled. A portion of the powdered enamel was used for a fusion block test.

In each case the smelting time was decreased slightly by the use of sodium silicate.

The acid resistance did not seem to be affected appreciably one way or the other.

The fusion test apparently showed a slight difference in favor of the sodium silicate.

One block of each pair (Fig. 2) has the suffix "S," meaning sodium silicate. These blocks were all fired at one time in an electric enameling furnace

having a hearth 60 by 120 inches, with heating coils at the top and bottom. The blocks were supported in a space about 12 by 12 inches in the center of the furnace, so that each block should receive the same amount of heat.

The two batches for No. 2AP are shown as typical of the difference in batch with and without sodium silicate.

TABLE I

No. 2AP

	Wt.	SiO_2	TiO_2	Na_2O	B_2O_3	CaF_2	ZnO	PbO	Sodium antimonate
Borax	16.0			2.64	6.00				
Flint	41.0	41.0							
Soda ash	21.5			12.43					
Sodium nitrate	8.0			2.93					
Fluorspar	3.0					3.00			
Zinc oxide	5.0						5.00		
Lead oxide	12.0							12.00	
Titania	3.0		3.0						
Sodium antimonate	12.0								12.00
	121.5	41.0	3.0	18.00	6.00	3.00	5.00	12.00	12.00

No. 2APS

Borax	16.00			2.64	6.0				
Sodium silicate	54.30	41.0		12.28					
Sodium nitrate	8.4			3.08					
Fluorspar	3.0					3.0			
Zinc oxide	5.0						5.0		
Lead oxide	12.0							12.0	
Titania	3.0		3.0						
Sodium antimonate	12.0								12.0
	113.7	41.0	3.0	18.00	6.0	3.0	5.0	12.0	12.0

IV. Plant Tests

Several 500-pound smelts of enamels 4AP and 4APS were made in the plant smelter.[3] This formula was similar to No. 2AP given above, except that it was harder. These smelts were drawn when no further bubbling took place in the melt. With one exception, all batches were smelted at 2100°F. The 4APS batches required about one hour and forty-five minutes for smelting, and the 4AP batches about two hours. The one exception, which is called No. X, was a batch of 4AP which was smelted at 2200°F for two hours.

All smelts gave enamels which worked satisfactorily. Those made with sodium silicate seemed to be slightly more acid-resisting and worked a little better than those made from quartz, with the exception of smelt X. Smelt X was as good as the 4APS in every way except opacity.

[3] The plant smelter in this instance was of an open-hearth type in which a temperature of 2200°F was easily obtained.

V. Fusion Test

From one smelt of No. 4APS, four fusion blocks were prepared. From one smelt of No. 4AP, four other blocks were prepared and from smelt X one block was prepared. These nine blocks were all fired at the same time. The agreement between blocks from the same frit was remarkable. All four of the No. 4APS blocks flowed 31 mm. down the face; all four of the No. 4AP blocks flowed 23 mm; the X block flowed 29 mm. Figure 3 shows these three blocks.

Samples of No. 4AP and No. 4APS powders were sent to George W. Morey of the Geophysical Laboratory. Dr. Morey reported that both samples consisted largely of glass containing particles of high refractive

FIG. 3.

index. There was in addition in No. 4APS less than 1% free quartz, and in No. 4AP there was 10% of free quartz.

VI. Conclusions

(1) It is possible to have an enamel which is apparently completely smelted, yet containing an appreciable amount of free silica. Obviously, such an enamel will not have the same properties that it would have if this silica were all combined.

(2) By increasing the severity of the heat treatment, all quartz can eventually be taken into solution, but the same thing can be accomplished at a lower temperature by the introduction of the silica in an easily fusible form.

(3) It would appear that sodium silicate would be of the greatest value to those plants smelting high silica enamels in low-temperature smelters. In any smelter it should decrease the smelting time and thus save some opacifier.

CHICAGO HARDWARE FOUNDRY CO.
NORTH CHICAGO, ILLINOIS

CONTROL OF DRAINING CONSISTENCIES OF ENAMELS BY ADDITION OF SODIUM SILICATE[1]

By Dwight G. Bennett

ABSTRACT

Additions of small amounts of sodium silicate to certain types of enamel slips has a deflocculating effect and thus greatly improves their draining properties. One-quarter of 1% of the weight of the frit was found most satisfactory. Additions up to 1/2% were not deleterious.

The wet weight per unit area method for control of enamel consistency is not at all reliable. Dry weight per unit area is the only accurate method for controlling the consistency of wet-coat enamels.

I. Introduction

The present paper is a continuation of previous work by Danielson[2] and deals particularly with the effect of the addition of a soluble alkaline salt on the draining properties of white cover enamels.

In the draining process of enameling it is usually necessary to add water to the milled enamels to obtain proper draining consistency. Enamels for dipping are usually milled with a relatively high clay addition to obtain dry strength and to prevent tearing during firing. This high percentage of clay, together with some setting-up action of tin oxide additions is likely to result in a thick slip requiring considerable thinning with water. It has been found that with some enamels an excess of water above the usual requirements must be added to bring about suitable draining properties, but in this event the weight of enamel retained may be insufficient to produce the desired opacity in the fired coat.

In choosing a suitable reagent, due weight was given to certain flotation and consistency results obtained by other investigators.[3] Sodium silicate was selected as the electrolyte most suitable for the tests.

II. Experimental Details

The electrolyte used was designated as 40° Bé sodium silicate. An analysis showed that it contained 9.19% of Na_2O by weight.

Two types of commercial cover enamels were used: enamel No. 1 only slightly soluble and enamel No. 2 relatively soluble (See Table I).

---

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Enamel Division). Received March 14, 1931.

[2] R. R. Danielson, "Effect of Soluble Salts on the Properties of Enamels," *Jour. Amer. Ceram. Soc.*, **12** [8], 538 (1929).

[3] R. R. Danielson, *loc. cit.*; H. F. Staley, Bur. Stand., *Tech. Paper*, No. 142, p. 75; H. E. Ashley, *ibid.*, No. 23, p. 17; H. L. Cook, "Effect of Electrolytes When Added to Enamel," *Jour. Amer. Ceram. Soc.*, **10** [5], 344 (1927); S. J. McDowell, "The Effect of Various Sodium Silicates and Other Electrolytes on Clay Slips," *ibid.*, **10** [4], 225 (1927).

These extremes of composition were selected because it seemed desirable to ascertain the effect of the salts dissolved from the frits during milling, both alone and in conjunction with the sodium silicate.

All experimental work was carefully kept uniform. Four ten-pound batches of each enamel were milled to the same degree of fineness: 11.5 grams of dry enamel on a 200-mesh screen.

TABLE I

RELATIVE SOLUBILITIES OF ENAMELS NO. 1 AND NO. 2 AS OBTAINED IN AN 800-LB. MILL

ENAMEL NO. 1

Grams of Na_2O/10 cc. mill liquor: 0.0240
Grams of B_2O_3/10 cc. mill liquor: 0.0196

ENAMEL NO. 2

Grams of Na_2O/10 cc. mill liquor: 0.0322
Grams of B_2O_3/10 cc. mill liquor: 0.0342

The mill additions were the same except that the batches contained varying percentages of sodium silicate as shown in Table II. All of the batches were aged 48 hours before using.

The enamels were applied by dipping 7- by 10-inch sheet-iron plates which had been plant enameled in a commercial ground coat. All plates were subjected to the same draining conditions, careful attention being given to the angle of 75° at which the plates were placed while draining, approximating the angle at which many enamels are drained commercially.

TABLE II

MILL BATCHES FOR ENAMELS NO. 1 AND NO. 2 SHOWING VARYING ADDITIONS OF SODIUM SILICATE

Batch No.	Frit (%)	Clay (%)	Tin oxide (%)	Magnesium carbonate (%)	Sodium silicate (%)	Water (%)
			Enamel No. 2			
2a	100	8	7	1/4		50
2b	"	"	"	"	1/16	"
2c	"	"	"	"	1/8	"
2d	"	"	"	"	1/4	"
2e	"	"	"	"	1/2	"
			Enamel No. 1			
1a	100	8	7	1/4		50
1b	"	"	"	"	1/16	"
1c	"	"	"	"	1/8	"
1d	"	"	"	"	1/4	"
1e	"	"	"	"	1/2	"

III. Results and Conclusions

In enamel No. 1, small additions of sodium silicate resulted in rapid changes in set-up. The minimum amount produced a distinct set-up while another small increase resulted in a distinct thinning down. As the amount

of sodium silicate was increased the thinning down continued, but at a less rapid and more constant rate. In enamel No. 2 very small additions seemed to have but little effect on set-up, but with additions exceeding 1/16% the relative effect became practically the same as that of enamel No. 1.

TABLE III

Batch No.		2a	2b	2c	2d	2e	1a	1b	1c	1d	1e
Water added after milling (%)	Sodium silicate in mill (%)	0.0	1/16	1/8	1/4	1/2	0.0	1/16	1/8	1/4	1/2
	Wet wt.*					1.67					2.68
None		T†	T	T	T		T	T	T	T	
	Dry wt.					1.23					1.90
	Wet wt.									4.00	
2.2		T	T	T	T		T	T	T		
	Dry wt.									2.68	
	Wet wt.				3.27					3.34	
4.4		T	T	T			T	T	T		
	Dry wt.				2.18					2.18	
	Wet wt.				2.76					2.76	
6.6		T	T	T			T	T	T		
	Dry wt.				1.82					1.82	
	Wet wt.				2.40						
8.8		T	T	T			T	T	T		
	Dry wt.				1.53						
	Wet wt.						4.72				
11.0		T	T	T				T	T		
	Dry wt.						2.90				
	Wet wt.			3.56			4.28				
13.2		T	T					T	T		
	Dry wt.			2.04			2.54				
	Wet wt.		3.63	3.20			3.48				
15.4		T						T	T		
	Dry wt.		2.25	1.82			2.03				
	Wet wt.	3.63	3.48	2.83							
17.6								T	T		
	Dry wt.	2.18	2.10	1.60							
	Wet wt.	3.12	2.98	2.47					3.34		
19.8								T			
	Dry wt.	1.82	1.82	1.38					1.96		
	Wet wt.	2.90	2.90					3.56	3.12		
22.0											
	Dry wt.	1.67	1.74					2.10	1.82		
	Wet wt.	2.47	2.54					3.34	2.62		
24.2											
	Dry wt.	1.38	1.53					1.96	1.45		
	Wet wt.							2.90			
26.4											
	Dry wt.							1.67			

* Wt. expressed in oz./sq. ft.
† *T* represents a consistency too thick for draining.

It is believed that the behavior of sodium silicate in enamel No. 1 more nearly represents its true effect on an enamel slip, since in this enamel soluble salts were at a minimum. In enamel No. 2, however, there was an increased amount of soluble salts in solution which, adding their effect to that of the sodium silicate prevented any initial set-up. It seems probable that

there must have been an initial set-up early in the milling but as the salts continued to dissolve, this was lost and at the end of the milling the consistency was that of an untreated slip. With continued additions of sodium silicate the effect of the soluble salts becomes less pronounced until with the addition of 1/4% the effect becomes negligible.

With about 1/4% sodium silicate the thinning effect becomes most uniform and reliable, regardless of the type of enamel used.

Uniform addition of water produces uniform decrease in dry weight, regardless of the concentration of sodium silicate. No sudden thinning out was found.

Since this is true, the problem simplifies itself into one of choosing the proper amount of sodium silicate to add so that the effect of soluble salts may be avoided, while at the same time securing suitable draining properties without excessive water addition. As stated above, this ideal amount seems to be about 1/4%.

It was found that suitable draining consistency and dry weight could be obtained with most of the batches but that in this case it was not possible to compare the wet weight to some previous standard. In other words, although a definite wet weight has been found to be correct with one enamel, it is not practical to use this same weight when using another and thicker enamel requiring more water to produce good draining properties. It is obvious that as the water content of the slip is raised the wet standard weight must also be raised since the solids content of the slip is decreasing.

The wet weight per unit area method for control of enamel consistency is not at all reliable. A slight variation in composition or smelting practice, mill additions, time of milling, or length of the aging process may cause a marked difference in the weight of dry enamel obtained on a given area from a certain wet weight.

It is folly to attempt to use the same weight per unit area on enamels of another type or on the same glass prepared or used under entirely different conditions. An example of this is afforded by batches 2*c* and 2*e*. (See Table III.) In 2*c* the weight of dry enamel retained was in all cases about 56% of the corresponding wet weight. In 2*e* the dry weight was 74% of the corresponding wet weight. Obviously, one standard wet weight could not be adopted for both.

Since the wet weight per unit area in itself tells so little about the resulting dry weight it should not be relied upon as a method of control. The use of an acceptable dry weight per unit area is the only suitable control test for wet-coat enamels.

CERAMIC RESEARCH LABORATORY
METAL & THERMIT CORPORATION
NEW YORK, N. Y.

POWER COST ON AN ELECTRIC ENAMELING FURNACE[1]

By M. E. Manson

ABSTRACT

With the furnace operating twelve hours per day, power consumption varied from 7 pounds of iron per kw.-hr. for light loads to 13 pounds per kw.-hr. for heavy loads. Operating in the daytime, this 215-kw. furnace increased the average plant demand 150 kw.

I. Introduction[2]

When the installation of an electric furnace for firing wet-process enamels on cast iron was being considered, several users were asked for figures on the operating cost. Apparently, however, no user knew what his furnace was costing to operate. Costs in cents per hour are of little value without a knowledge of the power rate and the pounds of iron to be fired per hour.

II. Operation of Furnace

A box-type furnace was purchased and some accurate figures expressed in kilowatt hours per pound of iron fired have been obtained.

The furnace was of 215-kw. capacity, with heating coils in top and bottom; the hearth was 10 feet long by 60 inches wide, and the height of the door opening was 30 inches. During the period of the test a special meter was installed which registered consumption to 0.01 kw.-hr. A demand meter was also connected to the furnace, which was left on for several months.

TABLE I

Total wt. of supports	35,142 lb.
" " " ware	54,406 lb.
" " " iron fired	89,548 lb.
" power consumption	8,657.58 kw.-hr.
" lb. iron/kw.-hr.	10.35
" " ware/ " "	6.28
" time operating furnace	77 hr., 0.03 min.
Av. lb. supports/lb. of ware	0.646
" time in furnace	28.8 min.
" wt. of support bars/load	264 lb.
" " " ware/load	408 lb.
" " " pieces fired	2.58 lb.
Total pieces fired	21,050
Heaviest piece fired	50 lb.
Lightest " "	0.375 lb.

---

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio (Enamel Division). Received March 14, 1931.

[2] The Public Service Co. of Northern Illinois furnished an assistant who counted and weighed all pieces on every load during the week the test was run. He did not make any changes in the usual plant operations and it is to be understood that this report is distinctly from a furnace user without any power company connections.

TABLE II

Load No.	Type of ware	Wt. per piece	Wt. of bars	Wt. of ware	Total iron	Wt. bars/wt. ware	Kw.-hr.	Lb. ware/kw.-hr.	Lb. iron/kw.-hr.	Time	Temp.	Coat No.
Preheat							100			1:00		
12–8	Chairbacks (12 in. high)	6.5	164.5	162.5	327	1.01	37.38	4.35	8.76	:20	1330	1*
12–5	Chairbacks (12 in. high)	6.5	209	299	509	0.70	69.42	4.32	7.34	:30	1330	1*
12–20	Sadirons	1.25	322	375	697	0.86	58.74	6.39	11.86	:26	1325	1*
13–6	Water tanks (12-in. cube)	50.0	95	750	845	0.126	90.78	8.26	9.31	:45	1340	1
16–20	Reflectors (14-in. diam.)	17.0	270.5	612	882	0.44	69.42	8.82	12.70	:43	1340	1
15–4	Water tanks and pedestals	50.0	104.5	820	924	0.128	96.12	8.53	9.61	:56	1340	1
		7.0										
15–10	Reflector canopies	5.0	289.5	660	949	0.44	90.78	7.27	10.44	:45	1340	1
13–20	Chairbacks (12 in. high)	6.5	183.5	188.5	372	0.975	37.38	5.05	9.96	:22	1325	2
17–19	Manicure bowls	2.0	304.5	192.0	496	1.58	58.74	3.27	8.45	:25	1320	2
13–22	Chairbacks	6.5	213.5	281.5	495	0.76	37.38	7.54	13.25	:18	1325	2
14–3	Sadirons	1.25	335	375	710	0.89	58.74	6.38	12.09	:27	1325	2
17–16	Reflector (14 in. diam.)	17.0	280	510	790	0.55	69.42	7.35	11.38	:37	1325	2
17–20	Reflectors	17.0	280	510	790	0.55	64.08	7.95	12.31	:33	1325	2
12–6	Reflectors	17.0	280	510	790	0.55	69.42	7.35	11.38	:37	1325	2
12–18	Scale platforms	17.5	104.5	595	700	0.18	58.74	10.12	11.90	:26	1325	2
14–6	Water tanks (12-in. cube)	50.0	95	750	845	0.126	74.76	10.02	11.30	:40	1325	2

* First coat, but same enamel as second coat.

Data Obtained

The furnace was operated about 12 hours every day during this test. Each morning the kilowatt-hours required to bring the furnace to operating temperature were noted; the following data were then taken for each load in the furnace: (1) weight of support bars, (2) type of casting, (3) number of pieces, (4) weight per piece, (5) total weight of load, (6) kw.-hr. consumption, (7) kw.-hr. per lb. of ware, (8) kw.-hr. per lb. of total iron, (9) minutes in furnace, (10) furnace temperature, and (11) notation of first, second, or third coat. Table I gives a summary of the week's operations.

The tremendous variation in the weights of the various pieces has a decided effect on the power consumption; *i.e.*, on one day, for a load in which the weight of supports was only 0.127 lb. per lb. of ware, 10.02 lb. of ware were fired per kw.-hr., while on the next load of material which was impossible to load heavy, the ratio of supports to ware was 0.894, and only 7.02 lb. of ware were fired per kw.-hr.

In Table II, therefore, are listed selected loads, varying from the lowest total weight to the highest. It was our practice to use a ground coat

next to the iron, followed by one coat of enamel. The ground coat being quite refractory, required a longer firing at higher temperatures. Table II presents figures on firing both ground and cover coats. For those plants which do not use a ground coat on cast iron the figures for second coat will apply to both coats.

III. Conclusions

The heavier the load, the more economical the firing, except that castings of uniform section throughout, such as chairbacks or sadirons, will fire more economically than heavier loads composed of castings of great inequality of section, such as reflector canopies or water tanks. Power costs run from about 7 lb. per kw.-hr. for bad loading conditions to about 13 lb. per kw.-hr. for the best loading conditions.

The writer's company has a flat rate of 0.8 cent per kw.-hr. plus $1.75 per kilowatt for the maximum half-hours' demand occurring during the month. The installation of an electric enameling furnace therefore will increase the plant demand by a certain number of kilowatts and this increase should rightly be charged against the furnace as part of the power cost. But the furnace will not increase the plant demand by the full amount of its rating. This furnace is rated at 215 kw. Over four successive months, the furnace demand occurring at the time of the maximum plant demand was, respectively, 147 kw., 88 kw., 130 kw., and 158 kw. A fair average to charge against the furnace would seem to be 150 kw. As is often the case, where the greater part of the plant demand is off during the night, the furnace can be operated at nights only, without adding anything to the plant demand. Under such operating conditions the furnace can fairly be charged only the energy rate.

Chicago Hardware Foundry Co.
North Chicago, Illinois

VISCOSITY OF GLASS BETWEEN THE STRAIN POINT AND MELTING TEMPERATURE[1]

By Howard R. Lillie[2]

ABSTRACT

An apparatus is described which employs the elongation of a glass fiber under load for the determination of annealing and strain points. The same apparatus is also used by varying the suspended load for the determination of the temperature-viscosity curve between the annealing range and the softening point of the glass. A description is given of measurements made in this manner on a series of three simple soda-lime-silica glasses at these low temperatures, as well as measurements made in a rotating cylinder viscometer between the softening point and the melting temperature. Curves are shown for the viscosities of the three glasses in the two temperature ranges and a complete viscosity curve from 500 to 1400°C is given for one of them. It is found that the two methods yield results that fit a smooth curve between these limits of temperature.

I. Introduction

During the last decade, a great deal of work has been done in several laboratories on the problem of measuring the viscosities of molten glasses. Contributions have been made by Washburn and Shelton, Stott, English, Proctor and Douglas, Lazarev, Volarovitch, Lillie,[3] and others, while English[4] has published a review of the apparatus and results of many of these. A further discussion of these high-temperature measurements need not be included here.

The temperature region below about 750°C for the ordinary lime glass is of particular concern, since extremely high viscosities, inaccessible to the usual rotating cylinder type of measurement, occur. Very little has been done toward studying glasses in this highly viscous state or toward expressing their viscosities in fundamental units. Littleton has described methods for finding the "softening point"[5] and annealing point[6] of a glass, but these methods are designed for determining temperatures corresponding to pre-assigned rates of viscous deformation and find their principal application in plant control. Originally, no effort was made to express the results in actual viscosity units.

The manner of measuring the softening point has remained practically

---

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Glass Division). Received May 11, 1931.

[2] Corning Glass Works, Corning, N. Y.

[3] H. R. Lillie, "Viscosity Measurements in Glass," *Jour. Amer. Ceram. Soc.*, **12** [8], 516 (1929).

[4] S. English, "The Viscosity of Glass," *Jour. Soc. Glass Tech.*, **12**, 106 (1929).

[5] J. T. Littleton, Jr., "A Method for Measuring the Softening Temperature of Glasses," *Jour. Amer. Ceram. Soc.*, **10** [4], 259 (1927).

[6] J. T. Littleton, Jr., "A Method for Determining the Annealing Temperature of Glass," *Jour. Amer. Opt. Soc.*, **4** [4], 224 (1920).

unchanged since it was described by Littleton, and is used as a quick check on the uniformity of production glasses. It consists of observing the temperature at which a fiber of specified size will elongate under its own weight at a given rate when suspended through a small furnace of specified dimensions. It was reported[7] that the viscosity computed for these conditions is roughly 3×10^7 poises and represents the softness of an ordinary lime glass at approximately 700°C. This point will be discussed further in this paper.

Annealing and strain points, according to Littleton's method, were found by observing the temperature at which a small cane of glass under torque would twist at a specified rate. The annealing point could be found directly from observations, while the strain point was determined by extrapolation of the logarithmic plot. In order to make these two reference points correspond directly to annealing practice, they were first arbitrarily defined as follows: the annealing point is that temperature at which a sample, comparable in size to ordinary ware,[8] will effectively anneal in 15 minutes, while the strain point is that temperature at which some four hours are required for the same amount of annealing. The strain point marks the approximate temperature below which permanent strains cannot be developed if the glass is cooled slowly enough to avoid breakage. The two points were accordingly determined directly for test pieces of a standard glass by means of polarized light. Torsion samples were then made up of the same glass and their rates of twist determined at these same temperatures. The annealing and strain points of a test glass of unknown characteristics were then assumed to be temperatures at which a similar sample twisted at the same rates as the standard sample.

The torsion method of Littleton, however, has been replaced by the fiber elongation method, with results at least equally dependable and with an appreciable saving in time. The apparatus is simple to construct, the samples less liable to break, and the consequences less serious when this does occur. The observations and curves obtained are quite similar to those of Tammann[9] who has also measured rates of elongation in the annealing range.

Since the softening and annealing points are both found by essentially the same method, an effort was made to determine completely the viscosity-temperature curve between these two regions. With this done, the entire viscosity curve of a glass would become available.

---

[7] H. R. Lillie, *loc. cit.*, p. 523.

[8] A cane 1 cm. diameter, 4 cm. in length, viewed lengthwise through polished ends.

[9] G. Tammann and E. Jenckel, "Rate of Stretching of Hot Glass Fibers," *Z. anorg. allgem. Chem.*, **191**, 122 (1930).

II. Special Glasses Used

(1) Melting Three special pure soda-lime-silica glasses were made up for the tests to be described. The batches consisted of silica known to contain less than 0.1% R_2O_3, $CaCO_3$ of Baker and Adamson C.P. quality, and soda ash and niter of high purity. About 7% of the total Na_2O content was introduced in the form of niter. Two batches of 500 grams glass equivalent were made up for each glass. Each of these batches was charged into a large platinum crucible as fast as possible without danger of overflow. The first melting was for about four hours, during which time the crucible was removed and the glass stirred vigorously with a platinum rod three times. The glass was then poured into water in a large silica container. After being dried and pulverized to less than $1/4$ inch size with a wooden pestle, the two batches of the same glass were mixed thoroughly, divided into two equal parts and the same melting schedule repeated. All melting was done in a platinum furnace at 1400°C. The resulting glasses still contained small bubbles but showed a high degree of homogeneity.

(2) Analyses Each glass was then analyzed with the following results as reported by the analyst:

	I (%)	II (%)	III (%)
SiO_2	69.73	71.38	71.95
Na_2O	20.96	19.34	20.77
CaO	9.05	8.89	6.78
K_2O	Trace	Trace	<0.10
R_2O_3	0.18	0.24	<0.10
Total	99.92	99.85	99.70

III. Experimental

(1) Apparatus
(a) Furnace The furnace used in making the low-temperature viscosity determinations was built as shown in Fig. 1. The iron core, *C*, is wound with nichrome IV ribbon separated from it by asbestos ribbon. The whole is covered with alundum cement. This core is drilled with a central hole as shown, a side hole from the top to contain the platinum thermocouple *TC*, and a similar side hole from the bottom for thermal symmetry. This core is supported at the ends by the transite rings and disks *T*, the space between it and the galvanized iron shell being filled with Sil-O-Cel.

(b) Temperature Measurements Temperatures were measured by means of the deflection of a wall-type galvanometer used in conjunction with a Leeds & Northrup students' potentiometer. The potentiometer dial was set at some definite temperature and the deflection of the galvanometer used as a measure of the deviation of the furnace from that temperature. The "constant" of the galvanometer was found to be about 2.3°C per cm. deflection in this case. Tem-

perature deviations read in this way were therefore accurate to less than one degree. The cold junction of the couple was maintained at 0°C at all times. It was found by trial that the temperature inside the central hole of the furnace core was as nearly the same as that read on the furnace couple as could be detected.

(c) Elongation Measurement The sample of glass is drawn into a fiber, the diameter of which is between 0.50 and 0.70 mm. with a maximum variation of ±0.01 mm. over its entire length. A total length of 50 cm. is used and the average cross-sectional area (expressed by R^2) found from its weight and density. After one end of the fiber has been fused to form a small ball, it is lowered through the furnace and through the conical hole in the brass grip, A_2. A ball is then fused on the lower end of the fiber to support the brass grip and suspended weights as shown in Fig. 1. The optical lever, L, rests upon the brass grip and a stationary platform which can be adjusted to the proper height. An ordinary telescope and vertical scale at about one meter distance is used for making readings of elongation.

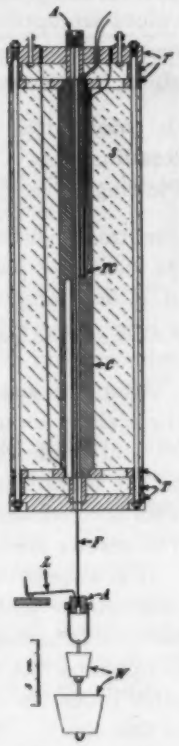


FIG. 1.—Low temperature viscosity apparatus.

(2) Annealing and Strain Points

(a) Mathematical As explained for the case of the torsion apparatus used by Littleton, the annealing point of a test glass can be determined simply by finding the temperature at which its apparent mobility or rate of deformation under definite conditions is the same as that of a standard glass at its annealing point, which has been independently determined by direct annealing experiments. In the case of fiber elongation, an expression for the mobility can be written:

$$M = \frac{\pi R^2 E}{Lmg} \qquad (1)$$

where R is the radius of the fiber; L, its length; and E, its rate of elongation as caused by a stretching force, mg. Now if L and m are the same for all determinations, M will be proportional to R^2E and it remains only to find the value of this quantity corresponding to the two reference points in question. Preliminary runs were, therefore, made on several "standard" glasses of known annealing points ranging from 425 to 550°C. A suspended mass, m, of 1 kg. was chosen, since if this is exceeded the fibers occasionally break. Very close agreement was found among the values of R^2E observed for the several standards, the results being

Annealing point	$R^2E = 5.5 \times 10^{-6}$
Strain point	3.5×10^{-7}

or in terms of logarithms, 4.74 − 10 and 3.54 − 10, respectively. These values are applicable when R is expressed in centimeters and E in centimeters per minute. The rate as directly observed in the telescope is about 4 mm. per minute at the annealing point.

(b) Method of Reading and Plotting The following description may be made of a single annealing point run.

It was observed early in the work that during the initial heating of the glass it apparently possesses an abnormally high mobility. After heating, however, to some 20° above its annealing point this effect disappears and the curve can be repeated in either temperature direction with very close agreement. For this reason observations are made only on decreasing temperatures for the ordinary run.

After the sample is introduced it is heated until the observed rate on the scale is about 3 cm. per minute. The furnace current is then turned off and readings commenced. Elongations are read when the timer is on the minute mark and temperature readings when it is at 30 seconds. This is continued until rates of less than 1 mm. per minute are observed. The results are then ready for plotting.

It is known that if logarithms of glass mobilities in this range of temperature are plotted against the temperature a linear relation is generally found. It is therefore convenient in plotting results to use not the actual elongations but the logarithms of observed rates; *i.e.*, actual elongation rates times the multiplying factor of the optical lever system (about 58 in this case). The point on such a curve corresponding to the annealing point will then be 4.74 + log 58 − log R^2, while that for the strain point will be 1.20 less.

(c) Tests on Special Glasses Curves so obtained for the three special glasses are shown in Fig. 2. It is quite obvious that the relations are nearly linear. The annealing and strain points as given by these curves are

	I	II	III
Annealing point	509°C	515°C	501°C
Strain point	479	482	469

By the position of these temperatures in Fig. 2, it may be seen that the annealing point is well within the actual observational range while the strain-point determination requires an extrapolation of some 10 to 20°C.

The principal advantage of this method over that of torsion lies in its rapidity without loss of accuracy. In actual practice it has been found that two successive samples seldom disagree by more than 1°C at the annealing point or more than 2°C at the strain point. Runs at widely

different times made on identical glass will agree nearly as closely. The behavior of the apparatus can be checked easily with a sample of standard glass and even if this is done and two samples of each test glass are run, one person can complete the work on five or more test glasses in a day.

Formulas used: (Equation (1))

$$M = \frac{\pi R^2 E}{Lmg}$$

for the mobility of the glass. Expressing this in terms of viscosity,

$$\eta = \frac{1}{3M} = \frac{Lmg}{3\pi R^2 E} \qquad (2)$$

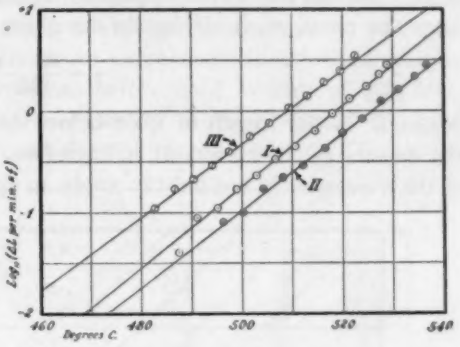


FIG. 2.—Annealing point runs.

Of these quantities all are known with the exception of L, the effective length of the sample. This length will depend on the temperature distribution in the furnace and also on the temperature itself since each part of the fiber will stretch as a unit whose viscosity is not a linear function of temperature. The value of L was therefore determined experimentally at various temperatures in the following way: A uniform fiber was placed in the furnace at constant temperature and allowed to stretch to such an extent that its diameter at the center of the furnace was considerably decreased. Then the change of length of the hottest centimeter of fiber at the center of the furnace, may be computed from the formula

$$\Delta l = \frac{-2\,\Delta R}{R}$$

and

$$\text{Effective length } L = \frac{\text{total } \Delta L}{\Delta l \text{ for 1 cm.}}$$

The values thus obtained varied quite consistently from 15 cm. at the softening point to 24 cm. at the annealing point. A curve could then be drawn for L as a function of temperature for use later in computing viscosities.

(d) Viscosities near the Softening Point

The softening points of the three glasses were first determined in the routine laboratory and were reported as follows:

I	670°C
II	679
III	665

These determinations were made in the regulation softening point furnace, similar to that shown in Fig. 1 except that the core is about 4 inches long

instead of 12 inches. Similar runs were made on the three glasses in the longer furnace, no weight being added to that of the fiber itself, and readings of the position of its end being made directly on a scale placed immediately behind it. A telescope was used in making these readings. Now since the mass, m, is all due to the glass itself, equation (2) becomes

$$\eta = \frac{LL'\rho g}{3E} \tag{3}$$

where L' is the length of fiber below the center of the furnace and ρ is the density of the glass. It is, therefore, not necessary to know the radius of the fiber exactly but only to apply an approximate correction to account

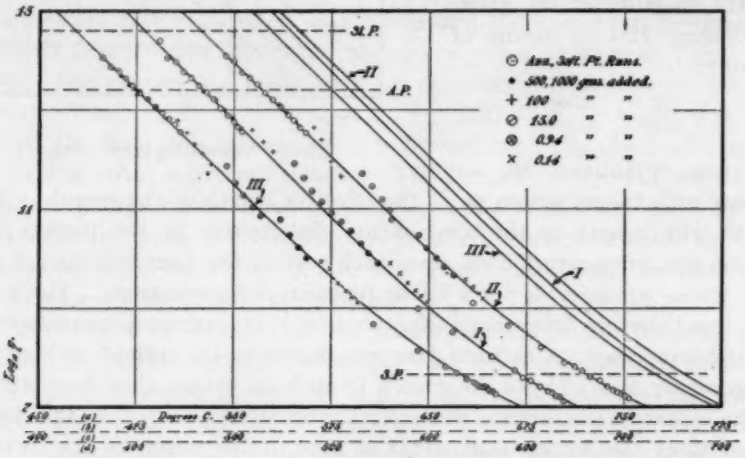


FIG. 3.—Low temperature viscosity curves. Temperature scales: (*a*) for glass III, (*b*) for glass I, (*c*) for glass II, (*d*) for comparison curves at right.

for its decrease as the fiber becomes considerably elongated. The results of these measurements are plotted at the lower ends of the curves in Fig. 3.

(e) Viscosities below the Softening Temperature

For determining viscosities immediately below the softening temperature, very little weight need be added to that of the fiber itself. To apply this small weight, a special optical lever was made upon which a small rider can be placed in either one of two positions. The moving end of the lever is supported by the ball on the end of the glass by means of two small prongs. The force exerted on these prongs is equivalent to 0.14 or 0.94 gram depending on where the rider is fastened.

A new fiber was always used when starting this part of the measurements. With everything all ready for readings and the optical lever exerting its smaller force, the temperature was brought up slowly until the rate of elongation, as observed in the telescope was two or three

centimeters per minute. The furnace current was then turned off and readings started in the same manner as described previously. When the rate had decreased to a few millimeters per minute, the rider was moved to its 0.94-gram position and readings resumed. When the rate had again decreased appreciably, the brass grip A_2 (Fig. 1) was put in place as quickly as possible. This grip, with no extra weights attached weighs 15 grams. Readings were continued as before until weights of 100, 500, and 1000 grams had been applied successively to the fiber and the rate of elongation had become very small for the largest weight. Viscosities

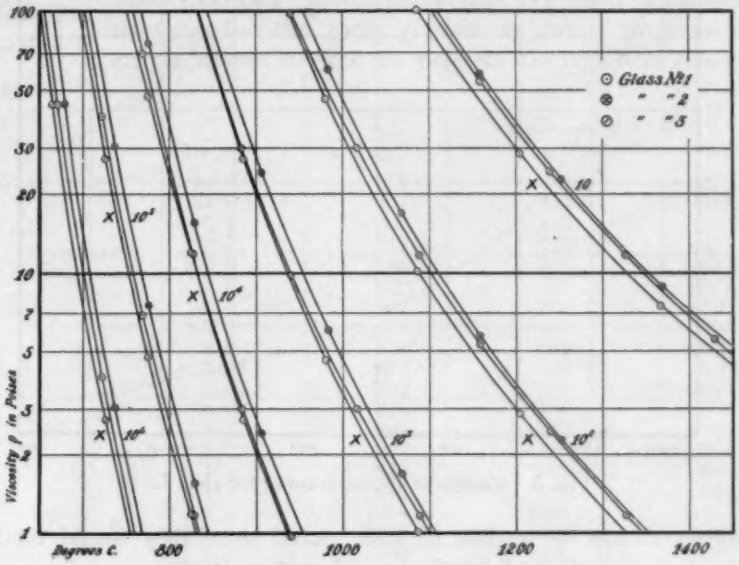


FIG. 4.—High temperature viscosity curves.

were then computed for all the observed rates of elongation. The results are plotted in Fig. 3, the different kinds of points signifying the various weights used. The points appearing as circles at the extreme upper ends of the curves are the same points as those in Fig. 2, recomputed into viscosity units.

(3) Viscosities at Reference Points From the curves shown in Fig. 3 the viscosities of the glasses at their various softening, annealing, and strain points can be read directly. The agreement among the three glasses is very good and the average values are as follows:

	$\text{Log}_{10}\eta$	η
Softening point	7.65	4.5×10^7 poises
Annealing point	13.40	2.5×10^{13}
Strain point	14.60	4.0×10^{14}

Horizontal lines have been drawn at these viscosities in Fig. 3.

(4) Plasticity and Surface Tension It will be observed in Fig. 3 that whenever a larger weight replaced a smaller one an apparent decrease took place in the viscosity. This is the typical behavior of a plastic medium. No attempt has been made to investigate this further. Another property which no doubt affects the results, especially where small forces are acting, is surface tension. These two

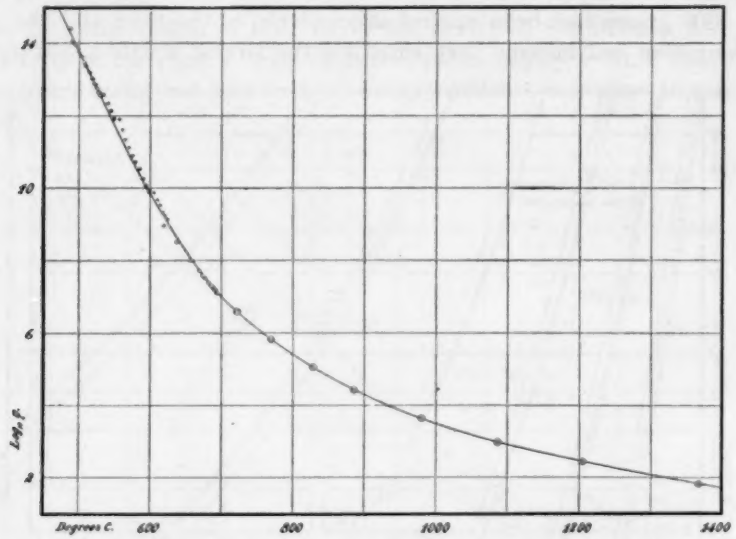


FIG. 5.—Complete viscosity curve for glass I.

properties should be studied in more detail since they would tend to vitiate the comparison of results by different methods.

(5) High Temperature Curves Ordinary viscosity runs by Margule's method described in previous papers, were made on the same three glasses. No special discussion of this method is required here; the results are plotted in Fig. 4. The folded type of plotting was used to show more clearly by how little the observed points depart from the curves. The points at 47×10^6 poises represent the softening points of the glasses.

(6) Complete Curve Figure 5 shows the complete viscosity curve for glass I. Each point is an actual observation and is not transferred from some other smooth curve. It is quite apparent that a smooth continuous curve can be drawn to represent the determinations. The decided bending upward in the curve at about 700° shows that something taking place in the glass causes its viscosity to increase with decreasing temperature at a much greater rate below the softening point than would be expected from an extrapolation of the high tempera-

ture curve. Since, however, the values of viscosity obtained by the elongation method and the rotating cylinder method were obtained by substituting measured quantities into formulas arrived at by appropriate mathematical analyses with constants obtainable wholly from geometrical dimensions of apparatus and not by the aid of any calibration substance of assumed viscosity, and since when expressed in the same units these values obtained by the two methods produce curves which meet and join perfectly, it seems natural to conclude that what has been measured and expressed here in c.g.s. poises is true viscosity.

(7) Results Tabulated The following table gives the viscosity-temperature relations for the three glasses, as taken from smooth curves drawn as well as possible through the observed points.

		Temperature °C		
	$\log_{10}\eta$	I	II	III
St. p.	14.6	479	482	469
	14.0	494	499	484
A. p.	13.4	509	515	501
	13.0	519	525	511
	12.0	545	551	537
	11.0	570	577	563
	10.0	596	604	589
	9.0	624	633	619
	8.0	658	668	652
S. p.	7.65	670	679	665
	7.0	702	709	696
	6.0	759	768	752
	5.5	793	803	798
	5.0	833	845	832
	4.5	888	903	891
	4.0	936	953	940
	3.5	1004	1024	1012
	3.0	1087	1109	1102
	2.5	1194	1206	1200
	2.0	1325	1352	1346

CORNING GLASS WORKS
CORNING, N. Y.

DESIGN AND CONSTRUCTION OF POLARISCOPES FOR USE IN GLASS FACTORIES[1]

By C. D. Spencer and Shannon Jones

ABSTRACT

This paper presents the most important considerations in the design and construction of polariscopes for routine factory use as found in the author's experience. A short summary of the various methods of obtaining plane-polarized light is given in which preference is given to the reflection method for this type of instrument. The use of binocular analyzers, together with the importance of the matching of the field colors due to the tint-plates, is pointed out.

I. Introduction

The polariscope first evolved as an instrument designed primarily for use in the physical or chemical laboratory. This instrument was usually fitted with a graduated head for determining the degree of rotation of the plane of polarization of various specimens, and had numerous adjustments and fittings to give it the degree of flexibility and adaptability necessary in a laboratory instrument. This instrument was obviously unfit for use in a factory; nevertheless, when glass factories began to realize the value of the polariscope in the detection of strained glass, this type alone was obtainable, and the demand of the factories for something better adapted to routine inspection brought to them a modification of the laboratory instrument of little value in either the factory or the laboratory.

II. Polariscope for Routine

(1) Simplicity Probably the most essential feature in a polariscope designed for routine factory use is simplicity. The presence of many adjustments and complications is both undesirable and unnecessary. The operator should be required merely to place the article to be inspected in the field of view and to detect the presence of strain by a change in the appearance of the field. Dependent on the thickness and other characteristics of the glass, the operator may reject all ware which modify the appearance of the field beyond a certain maximum, or he may reject all which bring about any variation whatsoever. In the particular case of the inspection of lamp bulbs having an average thickness of one-half millimeter, any change in the appearance of the field is an indication of considerable strain. Economic considerations should determine whether the entire production be inspected in this manner or whether only a certain fraction be examined as a check on the annealing.

---

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Glass Division). Received March 21, 1931.

(2) Ruggedness A second important qualification of the factory polariscope is ruggedness. The latest type to be put into use by the bulb and lamp factories of the General Electric Co. is shown in Fig. 1. It has a frame of welded angle-iron and is covered with $^3/_{32}$-inch sheet aluminum. The outside dimensions of the case, excluding the reflector, are approximately 39 by 17 by 22 inches. The unit is divided into two sections, the viewing chamber being 16 by 17 by 22 inches, the polarizing chamber 23 by 17 by 22 inches. The two parts are separated by a sheet aluminum partition having a glass-covered opening, a circle of 7 inches diameter, which subtends an angle of 22° at the nicol prisms. Since the presence of stray light has a tendency to reduce the apparent contrasts, both sections are painted mat black inside and the viewing chamber is open on the right side only.

(3) Light Source Although some of the first polariscopes were designed to use skylight as the light source, the variability and undependability of daylight as well as the fact that the operation of the instrument is limited to daylight hours make this light source undesirable. Later polariscopes have generally used the incandescent lamp as the light source. In the polariscope shown in Fig. 1 the source of light with its reflector is structurally separate and distinct from the body of the instrument. The reflector, which is fitted with a wire-glass diffusing screen, is a standard unit of a type used in many commercial installations and is designed for use with 1000- or 1500-watt lamps, although, of course, it may be used with lamps of lower wattage. This particular mounting of lamp and reflector has a number of advantages over the incorporation of the light source within the body of the instrument. It simplifies the replacement of the lamp and provides a greater dissipation of heat by air convection and in this way minimizes the probability of breakage of the glass plates.

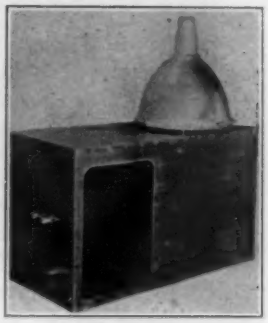


FIG. 1.

(4) The Cabinet Inside the cabinet and directly below the reflector is a frame supporting a ground-glass diffusing screen, over which is placed a plate of clear glass to prevent excessive collection of dust on the ground surface. The entire polarizing chamber is sealed and the upper surface of the clear glass is readily accessible to cleaning by raising the reflector. Despite the advantageous mounting of the reflector it has been found that continuous operation of a 1000-watt lamp in the reflector is quite likely to result in breakage of the ground-glass screen. For this reason a foot-switch is provided to insure that the

light will be on only during use of the instrument. An alternative would be to use a lower wattage lamp, which entails a loss of illumination with a corresponding decrease in ease of inspection. Previous models have been made of hard wood (Fig. 2), with lamps inside the cabinet. Despite

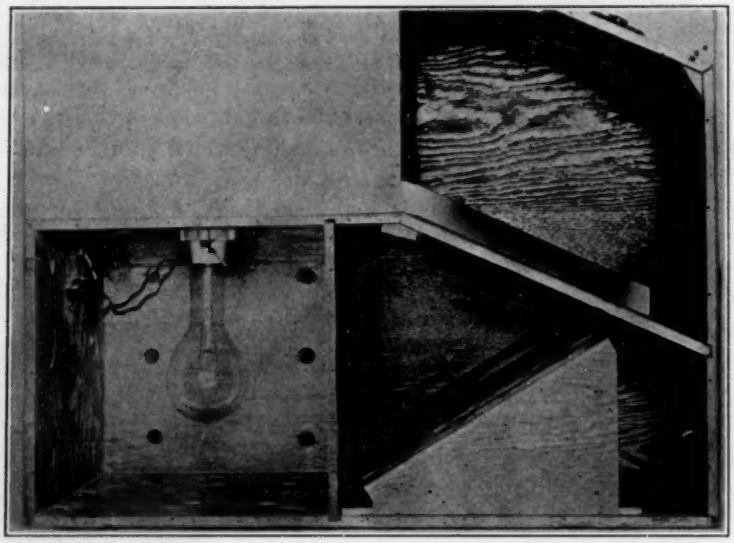


FIG. 2.

the use of fans to aid in heat dissipation, the amount of heat developed has been found to be so great as to cause the drying out of the wood, with resultant warping and cracking.

III. Obtaining Polarized Light

There are three general methods[2] of obtaining plane polarized light:

(1) Transmission through a properly cut birefringent crystal.
(2) Reflection at the proper angle from the surface of a dielectric such as glass.
(3) Transmission across one or more interfaces between transparent media of different refractive indices.

These three methods are not equivalent in their efficiency with respect to purity of plane polarized light obtainable or the fraction of the incident light transmitted.

(1) Transmission through a natural crystal of calcite, cut in the manner known as the nicol prism, produces the highest percentage of polarization as well as the highest transmission of the polarized light. Natural crystals,

[2] F. W. Preston, "The Use of Polariscopes in the Glass Industry," *Jour. Amer. Ceram. Soc.*, **13** [9], 595–623 (1930).

however, having a cross-section in the plane parallel to the optic axis greater than 2 by 2 inches are so rare as to be practically unobtainable, while the prisms obtainable commercially are usually less than one-half inch on a side. For the rapid inspection of ware it is essential that the field of view comprise a large part of the projected area, and preferably the entire area of the article being viewed. While it is possible to obtain a polarized field of considerable area by the use of a lens system which reduces the area of the beam as it passes through the nicols and afterward enlarges it to the size of field desired, it is simpler to obtain the polarized field by reflection from or transmission through a glass plate.

(2) Reflection from a black glass plate at the proper angle will produce practically complete polarization, but reduces the intensity of the polarized beam to about one-seventh[3] of the incident intensity.

(3) On the other hand, transmission through a series of six transparent plates would reduce the intensity of the polarized beam to less than 0.4 that of the incident beam. Of the two alternatives, polarization by reflection is probably the better, since the intensity of the incident light can be made sufficiently great to take care of the loss of light on reflection. The angle of maximum polarization of the reflected beam is given by the relation:

$$n = \tan i$$

Taking $n = 1.52$, i becomes approximately 57°, which, therefore, should be made the angle of incidence on the mirror for the central ray. Because of the angle at which light is reflected from the black mirror, polariscopes have often been constructed in awkward, ungainly shapes. These shapes are structurally poor, and since it is not essential that rays to the mirror be perpendicular to the ground glass diffusing screen, it is quite possible and advisable to make the cabinet rectangular in form.

IV. The Analyzer

The analyzer is the ocular or eye-piece of the system, consequently its aperture need be only sufficient to pass the rays from the observer's eye to all points of the field. It is this fact which makes possible the use of the nicol prism as the analyzer, and in view of its superior optical qualities, it is generally used in this position. When the analyzer is only a nicol prism, set at the angle of maximum extinction of the light reflected from the plane mirror, it will be found that the degree of extinction will not be uniform over the entire field of view, but will approach a maximum at a point in the field of view, from which point the field will increase in brightness radially in all directions. Only in the direction of the point of maximum extinction has the ray from the polarizing mirror to the nicol

[3] E. G. Coker and S. P. Thompson, "The Design and Construction of Large Polariscopes," The Proceedings of the Optical Convention, Vol. II (1912).

prism been both reflected at the angle of maximum polarization and polarized in the plane perpendicular to the polarization plane of the nicol. The introduction of moderately strained ware into a totally black field will in general produce only an increase of illumination. It can readily be seen that when such an effect is superimposed on the non-uniform field originally present, the interpretation of results is quite likely to be in error. This condition, together with the fact that the foregoing system is not so sensitive as could be wished for, makes it advisable to modify the appearance of the field by the introduction of a retardation plate. The use of such a plate, cut to give a retardation of 575 mμ produces a field of a violet color. This color is known as the first sensitive tint, since the change in appearance produced by the introduction of strained ware is more noticeable in a field of this color than in a field of any other color. Furthermore, the use of such a tint-plate in front of the nicol prism results in a field practically uniform in appearance.

A filter is used in front of the nicol and tint-plate to correct the tungsten light to the approximate color of daylight. The complete mounted unit, comprising nicol, tint-plate, and filter is obtainable commercially, but the retardation of the tint-plate desired should be specified since they are often made with a relative retardation of 500 mμ, producing a tint which is not quite so sensitive as that resulting from a 575 mμ retardation. If it is desired to use two or more polariscopes for intercomparison of ware in the same or different factories, it is better that the order for the required number of analyzer units be placed at the same time, with the specification that the tint-plates are to be matched, since a slight variation in the field color may result in misleading comparison of ware inspected in different polariscopes.

V. Operation

The operation of monocular instruments by persons unaccustomed to their use is usually attended by a certain amount of eye-strain, due to the tendency to close one eye. Even experienced users of monocular instruments find that in general the binocular type gives a clearer, more easily interpreted view of the object. Therefore, the latest polariscopes have been designed using two analyzers, adjustable for interpupillary distance. The prisms and tint-plate are locked in their proper positions by set screws so that they cannot get out of adjustment due to their being turned by workmen and inspectors who do not understand their function.

With the exception of the analyzers, which may remain unchanged, all optical dimensions may be increased in the same proportion, with no change in the effectiveness or sensitivity of the instrument. If the distance from the nicol to the window of the polarizing chamber be increased in greater ratio than the diameter of the aperture, the angular field of view

is decreased, with the result that any change in appearance of the field is in the direction of increased uniformity. A number of light sources may be used to give an extended source (ground glass) of uniform intensity. Practically speaking, there is no limitation on the size of polariscope which may be constructed.

GLASS TECHNOLOGY LABORATORY
GENERAL ELECTRIC COMPANY
NELA PARK, CLEVELAND, OHIO

THE INDEX OF REFRACTION OF SOME SODA-LIME-SILICA GLASSES AS A FUNCTION OF THE COMPOSITION[1]

By C. A. Faick and A. N. Finn

ABSTRACT

Twenty-one soda-silica and twenty-one soda-lime-silica glasses were made in platinum crucibles and the index of refraction and chemical composition of each glass were determined. From the data obtained equations were derived and a diagram was prepared showing the relations between index of refraction and composition of these glasses.

The diagram makes it possible to predict with considerable accuracy (1) the index of refraction of any glass in the range of compositions considered, from its composition, and (2) the compositions of the various glasses which have the same index of refraction.

Some evidence is presented indicating that index of refraction of the soda-silica glasses may be a simple function of certain soda-silica compounds which may be present in glass.

I. Introduction

Although the relation between index of refraction and chemical composition of glass has been given considerable attention in the past, most of the work has been done on glass whose composition and heat treatment are not definitely known. Many of the previous investigators based their work on compositions computed from the batch, disregarding material dissolved from the pot. Others analyzed the glasses and almost invariably found small amounts of oxides whose presence was unintended and complicated any adequate analysis of the data. Tillotson[2] and Peddle,[3] for example, based their work on batch compositions. Turner,[4] however, analyzed his glasses; but they contained varying amounts of Al_2O_3, Fe_2O_3, and MgO, which confuse the issue when studying a two- or three-component system. Consequently the results obtained by these investigators are not all that might be desired.

A diagram by Morey and Merwin showing the relations between composition and index of refraction of soda-lime-silica glasses has been published,[5] but the data on which these relations are based have not yet been presented.

Finn and Thomson,[6] analyzing such data as were available from the literature for the purpose, obtained a series of equations for expressing the relation between index of refraction and composition. Since their

---

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Glass Division). Received April 23, 1931.

Publication approved by the Director of the Bureau of Standards of the U. S. Department of Commerce.

[2] *Jour. Ind. Eng. Chem.*, **3**, 897 (1911); **4**, 246 (1912).

[3] *Jour. Soc. Glass Tech.*, **4**, 1920; **5**, 1921; **6**, 1922; **7**, 1923.

[4] *Ibid.*, **4**, 1920; **5**, 1921; **6**, 1922; **7**, 1923.

[5] International Critical Tables, Vol. II, page 102.

[6] *Jour. Amer. Ceram. Soc.*, **8** [8], 505–13 (1925).

analysis indicated that more satisfactory results might be obtained by further careful experimental study of the subject, it was decided that this work should be undertaken.

II. Outline of the Work

In order properly to investigate the variation in index of refraction with changes in chemical composition, it was considered desirable to study first the two-component system, soda–silica, and then to extend the work to the three-component system, soda–lime–silica. The composition of the glasses varied from approximately 50% each of soda and silica to 14% soda–86% silica in the two-component system; in the three-component system lime varied from approximately 3 to 15%.

To obtain glasses containing only the two or three constituents under consideration would necessitate the reduction to a minimum of all impurities in the batch material and the prevention of contamination during melting. Consequently only the best batch materials available were used. The soda and lime were introduced as sodium carbonate and calcium carbonate of reagent quality. The silica was prepared by pulverizing portions of a large, colorless, transparent quartz crystal.[7] The glasses were melted in a 25-ml. platinum crucible to prevent contamination during melting, and were annealed at approximately their highest annealing temperature. Although the glasses were made from pure materials and melted in platinum, their compositions were subsequently determined by careful chemical analyses.

III. Making the Glass

To produce the desired glasses a special platinum resistance furnace was constructed. The heating unit consisted of approximately 40 turns of 0.8 mm. 80% platinum-20% rhodium wire wound on an alundum core of the following dimensions: bore, 2 inches; wall, $^3/_8$ inch; length, 12 inches. It was surrounded by about one inch of electrically sintered magnesia, the rest of the insulation being diatomaceous silica. The furnace was supported about sixteen inches above the table to facilitate manipulations incident to melting the glass. The platinum crucible was handled by placing it in the end of a long refractory tube whose inside diameter was slightly less than the diameter of the crucible at the top. This "holder" when in place reached about half way into the furnace and extended about eight inches below it. It was so supported by a sliding clamp arrangement that it could be quickly raised or lowered and swung

[7] The significant impurities in the batch materials were found to be as follows: the sodium carbonate contained 0.002% SiO_2, 0.006% R_2O_3, 0.003% MgO, and 0.013% K_2O; the calcium carbonate contained 0.05% MgO; the quartz contained 0.075% non-volatile residue (with HF and H_2SO_4).

clear of the furnace for purposes of filling and stirring. (See Fig. 1.) A platinum and platinum-rhodium thermocouple for measuring temperature was placed inside the crucible-supporting tube, with its junction nearly touching the crucible and its terminals extending out of the lower end. Extension leads connected the thermocouple to a potentiometer.

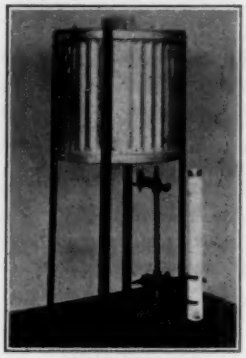


FIG. 1.—The melting furnace, showing the platinum crucible (in the refractory holder) in position for filling or stirring.

The filling was done at frequent intervals by lowering the crucible, swinging it clear of the furnace, and adding small amounts of batch. Stirring was done with a platinum rod, the crucible being in the same position as for filling. After the glass was free from seeds and carefully stirred to eliminate striae, it was poured from the crucible into an iron mold. This was done by removing the tube from its clamp and inverting it, thus obviating the necessity of handling the hot platinum crucible. The glass while still hot was transferred from the mold to a muffle furnace for annealing, the furnace being at a selected annealing temperature at the time of transfer (see Table I).

The size of the samples of glass obtained was approximately 50 by 30 by 5 mm.

IV. Measurement of Index of Refraction

The measurement of the indices of refraction presented difficulties because many of the glasses, especially those of low silica content, were very hygroscopic. In fact, most of them were so unstable that it was impossible to grind and polish Pulfrich slabs for index measurements. Consequently a different method was used. This was essentially an immersion method, whereby the index of refraction of a glass sample was matched by that of a liquid, and the index of the liquid then measured with an Abbé refractometer.

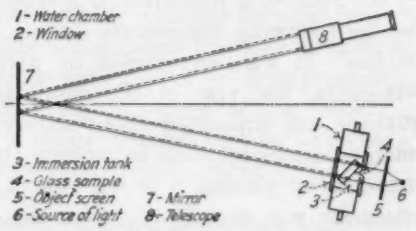


FIG. 2.—Diagrammatic sketch of immersion tank and optical system used in determining index of refraction. (The Abbé refractometer is not shown.)

The apparatus for measuring index of refraction by this method is illustrated diagrammatically in Fig. 2.

The immersion tank was equipped with two parallel plate glass windows to permit passage of light through the liquid, and was partially enclosed

by a water chamber through which tap water was continually flowing. Water from the same source was also flowing through the refractometer to keep both the immersion liquid and the refractometer at practically

TABLE I

COMPOSITIONS, OBSERVED AND CALCULATED INDICES OF REFRACTION, AND DIFFERENCES BETWEEN OBSERVED AND CALCULATED VALUES OF SOME SODA-SILICA AND SODA-LIME-SILICA GLASSES

Glass No.	Composition			Observed index	Computed Index and Differences				Annealing Temperature (°C)
	SiO_2 (%)	Na_2O (%)	CaO (%)		*A1*	*A2*	*B1*	*B2*	
1	50.04	49.96		1.5163	1.5159	−0.0004	1.5158	−0.0005	415
2	51.26	48.74		1.5146	1.5152	+0.0006	1.5153	+0.0007	420
3	52.15	47.85		1.5150	1.5148	−0.0002	1.5150	0.0000	420
4	54.14	45.86		1.5137	1.5137	0.0000	1.5136	−0.0001	420
5	57.45	42.55		1.5112	1.5116	+0.0004	1.5115	+0.0003	430
6	59.97	40.03		1.5099	1.5101	+0.0002	1.5097	−0.0002	430
7	62.86	37.14		1.5076	1.5076	0.0000	1.5075	−0.0001	440
8	63.06	36.94		1.5075	1.5077	+0.0002	1.5073	−0.0002	440
9	65.30	34.70		1.5055	1.5056	+0.0001	1.5055	0.0000	450
10	65.32	34.68		1.5055	1.5056	+0.0001	1.5055	0.0000	480
11	67.14	32.86		1.5042	1.5039	−0.0003	1.5041	−0.0001	500
12	69.65	30.35		1.5021	1.5015	−0.0006	1.5022	+0.0001	515
13	70.21	29.79		1.5014	1.5009	−0.0005	1.5017	+0.0003	525
14	70.44	29.56		1.5015	1.5017	+0.0002	1.5015	0.0000	525
15	72.15	27.85		1.4993	1.4992	−0.0001	1.5002	+0.0009	525
16	75.29	24.71		1.4965	1.4955	−0.0010	1.4967	+0.0002	560
17	77.85	22.15		1.4925	1.4923	−0.0002	1.4926	+0.0001	575
18	78.61	21.39		1.4912	1.4915	+0.0003	1.4914	+0.0002	575
19	79.73	20.27		1.4898	1.4900	+0.0002	1.4898	0.0000	575
20	83.00	17.00		1.4851	1.4857	+0.0006	1.4846	−0.0005	600
21	86.41	13.59		1.4790	1.4809	+0.0019	1.4794	+0.0004	600
22	52.65	43.05	4.30	1.5234	1.5233	−0.0001	1.5233	−0.0001	450
23	54.37	32.85	12.78	1.5391	1.5393	+0.0002	1.5394	+0.0003	530
24	56.20	34.00	9.80	1.5320	1.5322	+0.0002	1.5322	+0.0002	480
25	56.76	37.48	5.76	1.5238	1.5237	−0.0001	1.5236	−0.0002	470
26	58.41	38.54	3.05	1.5170	1.5172	+0.0002	1.5170	0.0000	480
27	60.32	24.50	15.18	1.5395	1.5404	+0.0009	1.5403	+0.0008	530
28	63.34	24.39	12.27	1.5320	1.5321	+0.0001	1.5321	+0.0001	525
29	64.14	21.22	14.64	1.5360	1.5361	+0.0001	1.5363	+0.0003	565
30	64.70	26.84	8.46	1.5232	1.5231	−0.0001	1.5233	+0.0001	525
31	65.71	28.79	5.50	1.5167	1.5163	−0.0004	1.5165	−0.0002	520
32	66.47	21.74	11.79	1.5288	1.5283	−0.0005	1.5286	−0.0002	565
33	67.30	29.43	3.27	1.5110	1.5103	−0.0007	1.5107	−0.0003	520
34	67.98	22.50	9.52	1.5230	1.5223	−0.0007	1.5228	−0.0002	565
35	70.50	23.00	6.50	1.5145	1.5136	−0.0009	1.5147	+0.0002	530
36	72.08	14.21	13.71	1.5265	1.5266	+0.0001	1.5268	+0.0003	580
37	72.61	24.24	3.15	1.5060	1.5047	−0.0013	1.5063	+0.0003	525
38	74.09	15.23	10.68	1.5182	1.5183	+0.0001	1.5181	−0.0001	545
39	74.81	12.14	13.05	1.5211	1.5222	+0.0011	1.5214	+0.0003	590
40	75.48	15.26	9.26	1.5138	1.5138	0.0000	1.5134	−0.0004	590
41	78.77	16.33	4.90	1.5003	1.5010	+0.0007	1.5002	−0.0001	545
42	80.59	16.17	3.24	1.4939	1.4955	+0.0016	1.4943	+0.0004	565

the same temperature, thus eliminating any significant errors that might arise from temperature differences. The thermometers in the immersion liquid and in the water jacket of the refractometer prisms never differed from each other by more than 0.25°C.

The "object" (*Sc* in Fig. 2) was a piece of fine-ground glass on which black cross-lines were ruled. The source of light was a sodium flame. A telescope for observation, a mirror, a clip for suspension of the samples, and a stirrer to mix the component oils of the immersion liquid were also provided.

Two oils were used, Halowax oil (n_D = 1.635) and a light mineral oil (n_D = 1.463), making it possible to obtain a mixture having any index between 1.463 and 1.635.

In making index measurements the object screen (*Sc*) was illuminated by the sodium flame (*S*), the light after passing through the oil (*O*) and the sample (*gl*) being reflected by the mirror (*M*) to the telescope (*T*). The telescope was focused on the lines of the object screen. Then the oil and the glass were matched for index by adding, with constant stirring, small amounts of one or the other of the oils to change slowly the index of the mixture until the mixed oils matched the glass. When not matched the lines of the object screen were distorted or broken up. Also, the lines visible through the sample shifted in position as the sample was rotated. When perfectly matched no distortion or shifting of the lines was observed regardless of the position, motion, or shape of the sample. The index of refraction of the oil was then measured with the Abbé refractometer. Of course, it was necessary to have glass samples relatively free from striae or the lines would be distorted by differences of index of refraction within the glass.

The reliability of this method was checked with several samples whose indices had previously been measured with a carefully calibrated Pulfrich refractometer. These indices were probably accurate to a few units in the fifth decimal place. The differences between the indices of refraction determined by the immersion and Pulfrich methods were less than two units in the fourth decimal place; these differences are within the limits of accuracy of the Abbé refractometer used.

V. Data Obtained and Results

Forty-two samples of glass suitable for index determinations were made. The compositions and indices of refraction of these glasses, and also the temperatures at which they were annealed, are given in Table I.

If the indices of refraction of the soda-silica glasses are plotted against the silica or soda content of the glasses, an approximately smooth curve will be obtained. Although a curve of this kind can be represented by a number of different equations, it was found that satisfactory values for the refractivity of these glasses could be computed by the equation

$$(N - 1) = 0.5054 + 0.000887A - 0.000013543A^2 \qquad (1)$$

in which N is the index of refraction for sodium light, A is the percentage

of silica, and the constants have been adjusted by the method of least squares.

Equation (1) can be arbitrarily divided into two others, one involving silica and the other involving soda; one group of such expressions is

$$(n_a - 1) = 0.005941A - 0.000013543A^2 \quad (2)$$

$$(n_b - 1) = 0.005054B, \quad (3)$$

in which A and B represent the percentages of silica and soda, respectively, and n_a and n_b represent their contributions to the index of refraction of the glass as computed for the silica and soda content from equations (2) and (3). Consequently,

$$(N - 1) = (n_a - 1) + (n_b - 1) \quad (4)$$

gives the refractivity for the two-component system.

For convenience, n will be called a "partial index" of the glass and when written with a subscript such as n_a, the subscript will indicate the particular oxide in the glass to which the corresponding capital letter refers. Regarding the derivation of equations (2) and (3), it is obvious that the effect of soda on the index of the glasses was assumed to be a linear function and all the curvature expressed by the last term in equation (1) was attributed to the silica.

If, now, it is assumed that the partial substitution of lime for soda in the soda-silica glasses does not affect the silica equation (2), then equations (2) and (3) can be used to compute the partial indices for the silica and soda in the glasses containing lime and the differences between the sum of these partial indices and the observed index of the lime glasses should yield data from which an expression for the partial index of lime can be computed. Proceeding on this assumption, the equation for the partial index of lime (C) is found to be

$$(n_c - 1) = 0.00707C \quad (5)$$

Hence for the soda-lime-silica glasses

$$(N - 1) = (n_a - 1) + (n_b - 1) + (n_c - 1) \quad (6)$$

may be used for computing the refractivities.

The results obtained by equation (6) for all the glasses considered in this report are given in column $A1$, Table I. The differences between the observed and computed values are given in column $A2$.

A consideration of the deviations (column $A2$, Table I) for glasses 1 to 21, which are listed in the order of their increasing silica content, suggests a decided tendency toward systematic variations; this might merely indicate that equation (1) is not exactly of the best type to express properly the relations between composition and index of refraction, but several other expressions (some involving fractional exponents and others including terms in the second power of N and the cross-product of N and

A) were tried with quite similar results. The explanation of this systematic behavior of the residuals is apparent when the soda-silica data are carefully plotted on a large scale. It then becomes evident that the index of refraction of the soda-silica glasses does not change with composition in a manner such as to form a continuous curve like the values computed by (1), but from the data presented it seems that a broken curve made up of segments of three straight lines will more accurately express the relations.

These straight lines apparently intersect at points corresponding to 59.5% and 73.75% silica and these percentages correspond quite closely to the silica content of $2Na_2O{\cdot}3SiO_2$ and $Na_2O{\cdot}3SiO_2$. This raises the question as to whether the changes in index with composition of the soda-silica glasses can be accurately represented by a smooth curve, as is ordinarily believed, or whether the index changes in a simpler (linear) manner which is directly related to certain molecular combinations which may be present in the glass.

Apparently this straight-line hypothesis can be applied to that part of the three-component system discussed in this report, for the index of refraction of the soda-lime-silica glasses can also be more accurately expressed by straight-line equations. The general equation for the soda-silica and soda-lime-silica glasses is:

$$(N - 1) = aA + bB + cC, \qquad (7)$$

in which A, B, and C represent the percentages of silica, soda, and lime as before, and a, b, and c are empirical constants having the following values in the indicated silica ranges:

Silica range (%)	a	b	c
50? – 59.5	0.004836	0.005491	0.007521
59.5 – 73.75	0.004785	0.005568	0.007598
73.75–100	0.004584	0.006127	0.007977

The 50% limit for silica is subject to question, because the indicated constants (a, b, c) for the silica range 50–59.5% may apply to glasses containing less than 50% silica. No glasses containing less than 50% silica were made. The limiting silica value of 73.75% applies only to the soda-silica glasses. For lime glasses it gradually changes, as the lime is increased, to approximately 71% silica when the lime content reaches 16%. The limiting silica value in this case is indicated by the line bb' in Fig. 3.

The division lines between two adjacent groups were located by solving the corresponding equations simultaneously for the points of intersection of constant index lines. It will be observed that the boundary, aa', between the first and second groups follows a constant silica line while bb' between the second and third deviates toward lower silica values as the percentage of lime increases.

The results obtained by the proper substitutions in equation (7) are given in columns $B1$ and $B2$ of Table I.

Comparing the deviations in columns $A2$ and $B2$ (Table I), it can be seen that those in $B2$ are appreciably smaller than those in $A2$ and also that the tendency to systematic variation is less evident in $B2$ than in $A2$.[8]

If equations (6) and (7) are used to calculate the compositions of glasses having the same index of refraction, and these compositions plotted on a tri-ordinate graph, lines of equal index of refraction are readily located. This was done and the resulting lines for equal index are shown in Fig. 3. The "dash" lines in Fig. 3 are the lines of equal index of refraction of the soda-lime-silica glasses computed from (6). The dotted lines are the equal-index lines determined by Morey and Merwin,[9] and the solid lines are those derived from (7).

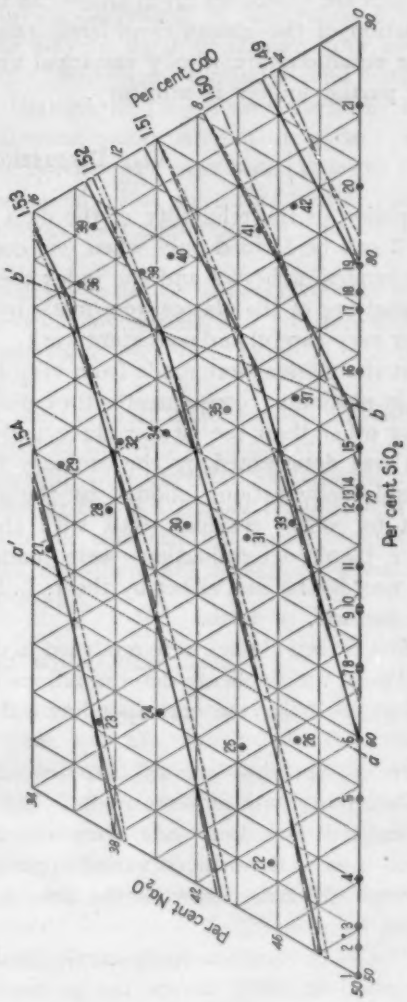


FIG. 3.—Diagram showing relation between composition and index of refraction of some soda-lime-silica glasses. The "dash" lines were computed from equation (6), the solid lines from equation (7), and the dotted lines are reproduced from diagram by Morey and Merwin.

It becomes evident, after considering Fig. 3, that there will be an infinite number of glasses containing only soda, lime, and silica that have the same index of refraction for sodium light. For example, the composition of a glass having an index of 1.51 may vary from 40% Na_2O–60% SiO_2 to approximately 11% Na_2O–10% CaO–79% SiO_2, provided the changes in composition follow

[8] These systematic variations can be more readily detected by plotting the differences at their corresponding points on a Na_2O–CaO–SiO_2 diagram.

[9] See footnote 5.

the 1.51 index line. Furthermore the index of a glass whose composition lies at a point between two index lines may be readily computed from the distances which separate the point from the adjacent lines.

Although the equations given above can be used to compute the indices of refraction of the glasses considered, one must bear in mind the fact that the equations are wholly empirical and the division into forms involving partial indices is arbitrary.

VI. Discussion

An opinion of the reliability of the data in Table I and of the curves in Fig. 3 can be formed only when one considers the probable accuracy of the chemical analyses and the index measurements.

The analyses of the glasses were made by F. W. Glaze, to whom credit is due for very careful and consistent work. His work was simplified by the fact that the glasses were made from very pure batch materials and were melted in platinum; consequently they did not contain more than traces of oxides other than the two or three under consideration.

Silica was determined by the ordinary fusion with sodium carbonate and double dehydration, followed by the addition of a small amount of alumina to collect residual silica with the ammonia precipitate. Appropriate blank determinations were made.

Soda was determined either by the J. L. Smith method, the zinc-uranyl acetate method, or both.

The first fifteen glasses were analyzed in duplicate. The average difference between the duplicate determinations of silica was 0.07%, the maximum being 0.16%; the corresponding values for soda were 0.09% and 0.17%.

In general, the lime glasses were not analyzed in duplicate nor were direct determinations of soda made. But for occasional checks, some determinations including soda were repeated, and the percentages of silica and soda as determined varied approximately as stated above while the average difference between the lime determinations was 0.03%, the maximum being 0.09%.

In all cases of complete analysis, the analyzed composition of the glass was adjusted to 100% before the percentages were used in computing indices.

The reported index of refraction of the glasses is an average of three or more determinations on the same sample. Since a few striae were present in some of these glasses, it is not certain that the accuracy of ± 0.0002, which has been mentioned as obtainable in the method of measurement, was reached in all cases. It is thought, however, that the maximum error is not more than ± 0.0005.

It has been shown[10] that the index of refraction (and also density) of a given glass may be materially changed by the temperature at which the glass is annealed. For instance, the index of refraction of a soda-lime glass similar to No. 39 (Table I) will increase 0.000032 for each degree the effective annealing temperature is decreased in the range 570 to 500°C; hence the index of No. 39 may be made to change from 1.5211 to 1.5232 by proper heat treatment. Such changes in index (and density) are probably brought about by changes in the physico-chemical constitution or equilibrium of the component constituents of the glass. Since equilibrium is attained much more quickly at higher than at lower temperatures, an effort was made to anneal all of the experimental glasses at high temperatures in order to reduce to a minimum the time required for annealing.

In view of the foregoing statements it is not to be expected that soda-lime-silica glasses which have known compositions and are annealed at materially lower temperatures than those used (see Table I) will have the indices indicated by Fig. 3.

Although it is recognized that the chemical analyses and the indices of refraction of the glasses considered in this paper are not of the highest possible degree of accuracy, it is thought that the relations between index of refraction and composition shown in Fig. 3 are more reliable than the individual determinations on which the relations are based because all the experimental data are included and there are no serious deviations between observed and computed values.

VII. Comparison with Other Data

The results obtained by Turner[11] were based on glasses containing small amounts of oxides of iron, aluminum, and magnesium. In the case of his data, however, if the amounts of iron and alumina are added to the silica, the magnesia is added to the lime, all compositions adjusted to 100%, and the resulting percentages substituted in equations (6) or (7) (or used in reading from Fig. 3), the agreement between observed and computed indices is very good. In fact, the average variation between the observed indices of his eleven soda-lime-silica glasses and the values computed from their compositions by these equations is less than 0.0007, the maximum being 0.0019.

Peddle's results do not give satisfactory agreement when considered in the same way as Turner's; this may probably be explained by the

---

[10] Tool and Hill, *Trans. Soc. Glass Tech.*, **9**, 196 (1925). Annual Report, Director, Bur. Stand., p. 25, June 30, 1929. Also Tool, Tilton, and Hill, *Jour. Opt. Sci. Amer., and R. S. I.*, **12**, 490 (1926).

[11] *Jour. Soc. Glass Tech.*, **4**, 111 (1920).

fact that his reported compositions were computed from the batch and may vary materially from the composition of the finished glass.

VIII. Conclusion

The significance of the work presented in this paper is threefold:

(1) It is possible to predict with considerable accuracy the index of refraction from the composition of any glass of the soda-lime-silica series in the range considered. (2) The compositions of the numerous glasses of this series that have the same index of refraction can be predicted. (3) This work may serve as a check on the accuracy of chemical analysis of such glasses because, if a glass is annealed at a reasonably high temperature, its composition as determined by chemical analysis should fall on the line in Fig. 3 representing its index of refraction.

There is also presented some evidence which suggests that the indices of refraction of the various soda-lime-silica glasses may be directly related to certain definite compositions (such as $2Na_2O{\cdot}3SiO_2$ and $Na_2O{\cdot}3SiO_2$) taken either singly or as simple mixtures, but more work must be done in order definitely to establish this point. This additional work is now under way.

THE DEVITRIFICATION OF "PYREX" GLASSES[1]

By George W. Morey

ABSTRACT

A study has been made of the devitrification phenomena of three "Pyrex" glasses, which were found to have liquidus temperatures lower than any other known mixtures containing so high a silica content. "Pyrex" glass 774 (702EJ), refractive index 1.471, has a liquidus temperature of 1077°; 772 (702P), index 1.485, 1042°; and 776 (720GO), index 1.473, 1036°. In all cases tridymite is the primary phase and cristobalite was never observed.

I. Introduction

"Pyrex" laboratory glassware is widely used for the construction of laboratory and industrial apparatus, and not the least of its good qualities is that of withstanding repeated working before the blowpipe without devitrification. The outstanding feature of all "Pyrex" glasses is their high silica content, together with a moderate amount of boric oxide, and for that reason it was deemed of interest to study their devitrification, and to compare with other glass compositions equally high in silica but containing other additional constituents. Three "Pyrex" samples were used, all kindly furnished by the Corning Glass Works. One of these was of the composition widely used for making beakers and flasks, and for the construction of laboratory apparatus out of tubing. The composition of this glass is given in the International Critical Tables[2] as: SiO_2, 80.75; B_2O_3, 12.00; Na_2O, 4.10; K_2O, 0.10; CaO, 0.30; $Al_2O_3 + Fe_2O_3$, 2.20; As_2O_5, 0.40; and the numerous other analyses in the literature[3] show a remarkable uniformity and constancy of composition. This glass is frequently known by the factory designation 774 (702EJ); the other two "Pyrex" glasses studied were 772 (702P) and 776 (720GO). The refractive indices of these three glasses, as determined by the immersion method, are 774, 1.471; 772, 1.485; 776, 1.473.

II. Devitrification by Quenching Method

(1) Method The devitrification was studied by the "quenching" method, which has often been described,[4] and which consists in holding small samples of the powdered glass at constant temperature long enough for equilibrium to be established, then ascertaining whether or not crystals are present, and their identity, by examination with the petrographic microscope.

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Glass Division). Received March 5, 1931.

[2] International Critical Tables, McGraw-Hill Book Co., Vol. 2, p. 89 (1927), "The Properties of Glass," by George W. Morey.

[3] P. H. Walker and F. W. Smither, Bur. Stand., *Tech. Paper*, No. 107 (1918). J. D. Cauwood and W. E. S. Turner, *Jour. Soc. Glass Tech.*, **2**, 219 (1918). W. E. S. Turner, *Jour. Roy. Soc. Arts*, **71**, 401 (1923). K. Thiene, *Glas und Apparate*, **5**, 1 (1924).

[4] See, for example, G. W. Morey, *Jour. Amer. Ceram. Soc.*, **13** [10], 683 (1930).

(2) Results The details of the experiment are given in Table I.

TABLE I

DEVITRIFICATION STUDIES OF "PYREX" GLASSES

Initial condition	Temperature °C	Time	Final condition
		"Pyrex" 774	
Glass	750	22 hr.	Much crystallization, but very fine and hair-like. Index not very different from glass, and probably both tridymite and cristobalite are present
Glass	835	18 d.	Much crystallization of both tridymite and quartz; no other crystalline phases
Glass	965	25 hr.	Much very fine tridymite, mostly in branching growths
Glass	990	12 d.	Much tridymite in needles and broad blades. Also rare prisms of much higher index, parallel extinction, positive elongation, but too few for identification
Glass	1045	8 hr.	Much tridymite in branching growths
Glass	1073	16 hr.	Few but good tridymite crystals, broad needles and blades
Glass	1080	16 hr.	All glass
Crystalline	1080	5 hr.	All glass
		Liquidus 1077°	
		"Pyrex" 772	
Glass	995	2 d.	Much tridymite
Glass	1012	1 d.	Much tridymite, well distributed
Glass	1039	2 d.	Few tridymite, not well distributed, but enough to be probably below liquidus
Glass / Crystalline	1044	3 d.	Both all glass
		Liquidus 1042°	
		"Pyrex" 776	
Glass	950	6 d.	Small amount tiny tridymite needles
Glass	955	2 d.	No devitrification
Glass	1022	2 d.	Numerous tridymite crystals
Glass / Crystalline	1040	3 d.	Both all glass
		Liquidus 1036°	

The devitrification of glass 774 was studied at fairly low temperatures, to obtain the secondary phase, but such a phase failed to appear. It may be that the few unidentifiable prisms obtained in the experiment at 990° represent this phase, but, if so, they do not correspond to any familiar compound. The experiment at 835° is also of interest. This is below the quartz-tridymite inversion temperature, but both of these phases were present. It will be noted that in the experiment at 1080°, tridymite dissolved in 5 hours. The crystals in this case were very fine needles, obtained in a short time at a slightly lower temperature. When the large tridymite crystals obtained by heating for 16 hours at 1073° were held for 7 hours at 1090° they failed to dissolve, although the edges of the broad blades had been etched, and the edges rounded.

The study of these glasses was of particular interest because of the

opportunity they afforded of distinguishing between tridymite and cristobalite. When one of these phases occurs in but small amount, and in tiny crystals, in a glass of refractive index higher than either of these crystalline phases, it is difficult indeed to be sure of the identification. Both often appear in branching growths, and both have but little birefringence under these conditions. But the refractive indices of all of these glasses are intermediate between those of tridymite and cristobalite, and in most cases there was no difficulty in distinguishing them. The only exception was the extremely fine crystals obtained with glass 774 at 750°. The glass was so crowded with very fine needles that it was difficult to be sure whether or not the crystals were of lower or higher index than the glass. It was concluded that both tridymite and cristobalite were present, but the identification was not certain. In every other case there was no doubt as to the identification of the crystals as tridymite; in no case did cristobalite crystallize in the tridymite field.

Concerning the other glasses there is little to add to the information in the table. Both have a liquidus temperature lower than 774, and only tridymite was obtained when they devitrified. 772 devitrifies more readily than 774, and 776 less readily, but all of these glasses devitrify less readily than either soda-lime-silica or potash-lime-silica glasses of similar liquidus temperature and high silica content.

III. Comparison with Other High Silica Glasses

It is of interest to compare the liquidus temperature of 774, 1077°, with that of other glasses containing 80% SiO_2. In the binary system, Na_2O–SiO_2, 80% SiO_2 corresponds to a liquidus temperature of 1135°, and addition of CaO raises this up to the temperature of formation of two liquid layers, a little below 1700°. In the binary system, K_2O–SiO_2, the corresponding temperature is 1160°, and again addition of CaO raises the liquidus temperature. Binary systems formed by SiO_2 with CaO, MgO, and Fe_2O_3 all show unmixing, at about 1700°, with 80% SiO_2. In the binary system, BaO–SiO_2,[5] the liquidus temperature is about 1677°. In the binary system Al_2O_3–SiO_2,[6] 80% SiO_2 is in the field of mullite, at about 1725°. The "Pyrex" glass 774 has the lowest liquidus temperature of any known mixture of so high a silica content, a temperature lower than that at which the glass is manufactured or worked, and in this fact doubtless is to be found the clue to its ability to withstand repeated working before the blowpipe without devitrification.

[5] The data in regard to these unmixing temperatures, and to the BaO–SiO_2 system, are taken from J. W. Greig, *Amer. Jour. Sci.*, **13**, 1 (1927).

[6] N. L. Bowen and J. W. Greig, *Jour. Amer. Ceram. Soc.*, **7** [4], 238 (1924).

GEOPHYSICAL LABORATORY
CARNEGIE INSTITUTION OF WASHINGTON
WASHINGTON, D. C.

February 7 to 12, 1932
Hotel Willard, Washington, D. C.
is the
Date and Place of the
Thirty-fourth Annual Meeting

American Ceramic Society

The Program Is Outlined

Only Six Months Remain for Submission of Papers

You will wish to be honored by acceptance of your paper for presentation at this Washington Meeting

---

Early planning and diligent care in preparations will be necessary

CERAMIC ABSTRACTS[1]

Compiled by the

AMERICAN CERAMIC SOCIETY

ROSS C. PURDY, Editor

ABSTRACTORS: H. W. ALEXANDER, A. ALLY, A. A. AVARS, R. BARTA, L. T. BROWNMILLER, E. C. CLEMENS, R. H. EWELL, M. A. EWER, C. G. HARMAN, R. A. HEINDL, E. B. HEWITT, M. Y. HODGDON, H. INSLEY, S. KONDO, M. V. KONDOIDY, W. LERCH, G. H. MCINTYRE, W. W. MEYER, R. G. MILLS, A. J. MONACK, J. D. REDUE, E. P. REXFORD, I. RHODE, D. E. SHARP, G. R. SHELTON, H. H. STEPHENSON, E. J. VACHUSKA, M. J. G. WESTFELDT, A. E. R. WESTMAN, W. C. O. WHITE.

Vol. 10 **July, 1931** **No. 7**

Abrasives

New property of fused alumina abrasives. HENRY R. POWER. *Metal Cleaning & Finishing*, **3** [4], 339–40 (1931).—The "abrasive value" of fused alumina abrasives which is important in considering polishing efficiency may be determined by the newly developed penetrometer test which is described in detail. Illustrated. E.J.V.

Grinding facts. II. ANON. *Abrasive Ind.*, **12** [4], 31–32 (1931).—A grinding wheel is made up of (1) abrasive grains, (2) bond, and (3) pores. Wheels are classified according to (1) bond, (2) kind of abrasive, (3) abrasive grain size, and (4) grade or hardness of the wheel. The structure usually is held constant. The processes are vitrified, silicate, shellac, rubber, or synthetic resin. Three-quarters of all grinding wheels made are vitrified. Vitrified wheels are made by two processes, puddled and pressed. They have a great range of hardness combined with porosity and free-cutting properties, are not affected by water, oils, acids, soda, or ordinary temperatures, and are used for either wet or dry grinding. In the silicate process the abrasive grain is mixed with sodium silicate (water glass) and when dry, the wheels are baked in ovens held between 400 and 550°F. Silicate wheels can be made up to 60-in. diameter. Wheels bonded with shellac are adapted to light grinding and are elastic. Synthetic resin such as bakelite or redmanol is a common bonding agent. Wheels made by this process are elastic and may be made in thin sections. They are run at high speed with a minimum of breakage danger. Exceptionally tough, strong grinding wheels are made with rubber as a bonding agent. They must be used at surface speeds of 8000 to 10,000 ft./min. to secure the best cutting action as it is necessary to melt the bond by friction against the work. Rubber-bond wheels are used for cutting-off, notching, etc., and for rough snagging. For Part I see *Ceram. Abs.*, **10** [6], 399 (1931). E.P.R.

Efficient grinding requires best wheel. ANON. *Abrasive Ind.*, **12** [5], 24–25 (1931).—Table II may be used as a basis for adapting the abrasive to the work to be ground.

TABLE II

ELECTRIC-FURNACE GRINDING ABRASIVES

Silicon Carbide (Hard, low-tensile strength materials)	Silicon Carbide (Materials needing sharp cutting)	Fused Alumina (Tough, high-tensile strength materials)
Cast iron	Fiber	Carbon steel
Chilled iron	Rubber	Alloy steel
Marble	Leather	Malleable iron
Granite	Aluminum	
Pearl	Copper	

[1] The abbreviation (*C.A.*) at the end of an abstract indicates that it was obtained from *Chemical Abstracts* by coöperative agreement.

The bold-face number following the journal name is the volume, the issue number is in brackets followed by the page numbers, then the year in parentheses.

The selection of bond should be based on the size and shape of the wheel, the cutting rate and wheel speed, and the finish desired. The vitrified-bond wheels are porous and free cutting and are adapted to general shop use including dry cutter and tool grinding, snagging at medium speeds, cylindrical grinding, and surface grinding. Vitrified wheels are the most commonly used of all grinding wheels. Silicate wheels can be made in larger diameters than vitrified wheels but are more dense and not so free cutting as the latter. Silicate wheels are particularly adapted to wet grinding on hardened steel. They are outstanding in wet-tool grinding and wet-surface grinding. Shellac wheels possess elasticity of bond and may be used in sections as thin as $^1/_{32}$ in. They are used chiefly for fine grinding with little stock removal. They are smooth cutting and give a fine finish either wet or dry if properly graded for the work. Rubber-bond wheels can be made much harder than shellac wheels and have a dense structure. They are exceptionally strong and may be run at speeds as high as 10,000 surface feet per minute. Cutting-off, slotting, and regulating wheels on centerless grinders often are made with a rubber bond. Wheels bonded with synthetic resins have great strength yet have an open, porous texture producing a free-cutting action. They are used on high-speed machines for snagging and as slotting, cut-off, saw gumming, and cam-grinding wheels. Coarse grits (designated by low grit numbers) are adapted to rough grinding and heavy stock removal. Precision grinding with a fine finish is carried out with the finer grits. Proper truing and dressing in machine grinding enables a fine finish to be obtained with the coarse grit sizes. Ductile materials, in general, require coarser grits than hard, brittle materials. E.P.R.

Roughing and finishing wheels used on surface grinder. ANON. *Abrasive Ind.*, **12** [5], 32–33 (1931).—The Blanchard Machine Co. has developed an automatic surface grinder which operates like the single-wheel machine, but has two wheels under which the work passes in succession, and each wheel is controlled independently of the other by its own wheel-control caliper. This makes it possible to control the finished size and the amount of stock left for the second, or finishing, wheel. E.P.R.

Aircraft engine parts finished by disk grinding. ANON. *Abrasive Ind.*, **12** [5], 23 (1931).—The thick abrasive circles which are replacing the former glue-bond disks are described. Disk grinding removes irregularities from rough castings to generate plane surfaces. The plant of the Curtiss Aeroplane & Motor Co. is described and illustrated. See also *Ceram. Abs.*, **10** [4], 241 (1931). E.P.R.

Grinding parts for airplane engines. HERBERT R. SIMONDS. *Abrasive Ind.*, **12** [5], 14–18 (1931).—In the plant of the Pratt & Whitney Aircraft Co., grinding of airplane parts to a tolerance of 0.0002 in. is common practice. Illustrated. E.P.R.

Centerless grind axle housings. ANON. *Abrasive Ind.*, **12** [5], 34 (1931).—An interesting application of the centerless method of grinding is a set-up for grinding both end diameters of rear axle housings on a Cincinnati No. 2 centerless grinder. The outboard support method of in-feed grinding is employed. Two rollers are positioned on the special outboard support fixture so that one end of the housing may have a freely moving support while the other end which is being ground rests on the work blade between the grinding wheel and the regulating wheel. A reciprocating attachment for the grinding wheel improves the finish and increases the life of the wheel per dressing. Stock removal is 0.020 to 0.025 in. and production totals approximately 100 completely ground housings per hour. Illustrated. E.P.R.

Grinder for tungsten-carbide tools. ANON. *Brass World*, **27** [4], 89 (1931).—The use of tungsten-carbide tools for cutting metals at high speed necessitates equipment for sharpening such tools. The U. S. Electrical Tool Co. has developed a grinder for this purpose, known as the "U. S. Tungsten Carbide Tool Grinder." E.P.R.

Grinding tungsten-carbide tools. ANON. *Abrasive Ind.*, **12** [5], 33–34 (1931).—

T. B. Wood's Sons Co. has developed a machine for grinding tungsten carbide which is fitted with two tilting tables that can be set accurately at the required angle from the horizontal. A quadrant indicator insures the correctness of the angle. A tool guide mounted on a straight edge travels in slotted ways parallel with the edges of the grinding wheel. The tool guide can be set at any angle to the cutting edge of the grinding wheel by adjusting the protractor which is integral with the guide. E.P.R.

Progress of internal grinding. HAROLD L. BLOOD. *Abrasive Ind.*, **12** [5], 22 (1931).—One of the basic improvements in internal grinding machine design is the utilization of a hydraulic cylinder to reciprocate the wheel in place of the gears and clutches previously employed. Gaging methods are explained and high degree of accuracy is discussed. Holes can be ground on a production basis with an average out-of-roundness of only 0.00005 in. E.P.R.

Precision grinding in automobile engine rebuilding. F. B. JACOBS. *Abrasive Ind.*, **12** [5], 19–22 (1931). E.P.R.

Hydraulic grinder has wide wheel. ANON. *Abrasive Ind.*, **12** [5], 34–35 (1931).—A hydraulic surface grinding machine of 10- x 12- x 24-in. capacity is announced by Norton Co. It has sufficient power and well-distributed weight to handle a wide range of work. The cutting is on the periphery of the wheel which produces a straight-line, velvet finish. E.P.R.

Portable grinder gage. ANON. *Abrasive Ind.*, **12** [5], 35 (1931).—A portable grinding gage produced by the Coats Machine Tool Co. gages work on cylindrical grinders, eliminating stopping the machine. All contact points exposed to wear are faced with tungsten carbide. E.P.R.

Portable grinder and buffer. STANDARD ELECTRIC TOOL CO. *Brass World*, **27** [4], 86 (1931); *Abrasive Ind.*, **12** [5], 37 (1931); for abstract see *Ceram. Abs.*, **10** [6], 400 (1931). E.P.R.

Studies in metal polishing. I. EDWIN M. BAKER AND GEORGE E. HOLBROOK. *Metal Cleaning & Finishing*, **3** [4], 297–302 (1931).—The experimental polishing machine is described and the relation of wheel pressure, accuracy of abrasive grain sizing, glue concentration, length of polishing time, and top dressing to polishing efficiency and cutting speed is discussed. Illustrated. E.J.V.

Automatic polishing and buffing machine. C. I. PACKER TOOL & DIE CO. *Metal Cleaning & Finishing*, **3** [4], 347 (1931); for abstract see *Ceram. Abs.*, **10** [5], 317 (1931). E.J.V.

Buffers with one and two motors. ANON. *Brass World*, **27** [4], 84 (1931).—The Cincinnati Electrical Tool Co. buffers have V-belt drives and either one or two motors, the latter for independent operation of spindles at different speeds to suit various types of work, including the heaviest polishing jobs. E.P.R.

Polishing household utilities. ANON. *Abrasive Ind.*, **12** [5], 38–41 (1931).—The polishing operation and types of machinery used in the plants of the Apex Rotarex Co. are described and illustrated. E.P.R.

Gear for variable speed. ANON. *Abrasive Ind.*, **12** [5], 36–37 (1931).—A multi-speed reduction gear unit built in combination with a standard a.c. motor, developed by the Westinghouse Electric & Mfg. Co., is constructed to give four speeds to the output shaft at constant horsepower. E.P.R.

Water-cooled spindle bearings. ANON. *Abrasive Ind.*, **12** [5], 37 (1931).—A salient feature of an internal grinder, built by the Wicaco Machine Corp., is the water-cooled wheel head which operates continuously with no appreciable rise in the bearing temperature. The oil chamber and bearings are surrounded by a large cooling jacket through which the ordinary grinding coolant is pumped continuously. E.P.R.

Abrasive industries in Canada. ANON. *Chem. News*, **142** [3699], 150 (1931); for abstract see *Ceram. Abs.*, **10** [4], 243 (1931). G.R.S.

PATENTS

Swing grinder. FREDRICH W. AND WILLIAM A. MARSCHKE. U. S. 1,800,307, April 14, 1931. In a swing grinder, a suspended annular bearing including outside and inside relatively rotatable members, a pin and slot connection between the members limiting the extent of relative rotation thereof, a frame extending through the bearing perpendicular to its plane of rotation and supported by the inner member, a grinding wheel at one end of the frame and a motor at the other, the pin and slot connection including means for clamping the members in different relative angular positions, handles for tilting the frame, and a clamp-operating handle for the pin and slot connection extending to a point adjacent the first-mentioned handles.

Rotary abrasive machine. JOHN D. DAVIES. U. S. 1,800,341, April 14, 1931. In a device of the character specified, a rotary bit provided with an annular flange having transverse passages and formed in its body portion with radial air openings, a cushioning member carried by the flange of the rotary bit and having transverse passages registering with those in the flange, an abrasive unit comprising a rotary cutting disk positioned over the cushioning member and having transverse passages registering with those of the latter, a vacuum device, means associated with the vacuum device for creating a suction through the transverse passages of the abrasive unit, cushioning member, and flange of the rotary bit and the radial openings in the body portion of the latter, means for actuating the rotary bit, and means comprising a tapering bushing and screw for removably securing the abrasive unit to the rotary bit.

Table for grinding apparatus. HENRY L. KEHL. U. S. 1,801,048, April 14, 1931. Apparatus for feeding bars to a grinding machine, comprising a table, means for feeding a bar along the table, supports for the table, racks mounted on the supports and extending transversely of the direction of feed, guide rails mounted on the supports, guide wheels supported by the guide rails, the guide wheels carrying the table, and pinions carried by the table and adapted to coöperate with the racks.

Grinding machine. CHARLES H. NORTON. U. S. 1,802,389, April 28, 1931. A grinding machine comprising a rotatable member having an annular abrading face, a work cage arranged to hold a plurality of pieces of work simultaneously in contact with the face, a member on the opposite side of the work cage and coöperating therewith to hold the work pieces in contact with the abrading member, means for rotating the cage eccentric to the abrading face so that the work will contact with the entire face, means to rotate the abrading member, and means for automatically loading pieces of work into the cage.

Grinding machine. RAYMOND WEBSTER. U. S. 1,802,798, April 28, 1931. In a machine of the class described, a work spindle, indexing mechanism for imparting a step-by-step rotary movement to the work spindle, a reciprocable table, a tool mounted on the table, adjustable stops on the table for controlling the movement thereof, and a lug mounted on the table in position to actuate the index mechanism before the table has reached the limit of its movement in one direction.

Truing and dressing grinding wheels. FERDINAND J. HOHNHORST AND FERDINAND J. KROEGER. U. S. 1,803,062, April 28, 1931. In a device of the character described, the combination of an axle, a member thereabout, a bearing between the member and the axle, and a flexible disk, a radially expressible packing and a complemental wall about the axle at the end of the bearing, the inner periphery of the radially expressible packing normally hugging the axle, the radially expressible packing located between the flexible disk and the complemental wall, and forming arresting means for protecting the bearing,

and the bearing provided with a part which shifts axially upon wear in the bearing, the shiftable part acting on the flexible disk to flex the disk axially and thereby radially expressing the expressible packing and thereby causing the inner periphery of the flexible packing to shift radially toward the axle to maintain a hugging relation between the inner periphery of the radially expressible packing and the axle.

Centerless grinder. CLEMENT BOOTH. U. S. 1,803,165, April 28, 1931. The combination with a centerless grinder including opposed grinding and regulating wheels and an intermediate work support of a work-feeding attachment therefor, including supports adapted to be mounted adjacent the machine, work-supporting rolls carried by the supports, means for vertically adjusting the rolls to bring their operative surfaces in position to maintain the axis of a work piece parallel with the work support, means for positively driving certain of the rolls to impart a rotative movement to a work piece resting thereon, and means for angularly adjusting others of the rolls to vary the longitudinal feed of work in rotative engagement therewith.

Sharpening mechanism for grinding machines. ROBERT E. READ. U. S. 1,803,487, May 5, 1931. In combination with a grinding machine provided with a rotary grinding element, a traversing carriage movable crosswise of the grinding face of the element, a slide mounted on the carriage and movable relatively thereto to and from the grinding face, a sharpening tool carried by the slide, mechanism mounted on the carriage and operatively connected with the slide for moving it on the carriage, a rotary shaft extending in the direction of movement of the traversing carriage and having operative engagement with the mechanism in the different positions of the carriage, a power cylinder and a piston therein operatively engaged with the shaft for rotating it, and means for controlling the operation of the piston.

Grinding machine. HERBERT E. TOWNSEND. U. S. 1,803,492, May 5, 1931. A grinding machine having, in combination, a grinding wheel mounted to move toward and away from the work, means for supporting the work, cross-feed mechanism for moving the grinding wheel comprising a ratchet wheel, a pawl, a pawl carrier for actuating the pawl to rotate the ratchet wheel, means for throwing the pawl out of operation at a predetermined joint in the rotation of the ratchet wheel, and means for adjusting the position of the pawl on the pawl carrier to vary the limit of the pawl feeding stroke a fraction of a tooth.

Grinding machine. CHARLES H. NORTON. U. S. 1,803,807, May 5, 1931. A grinding machine comprising a base having parallel ways thereon, two tables mounted on the ways for reciprocation past each other, one of the tables constituting a work support, a wheel slide on the other table which is reciprocable transversely thereof, a rotatable grinding wheel carried on the slide, a cross-feed mechanism to move the slide and feed the grinding wheel relative to the work, a single driving and reversing mechanism to reciprocate the tables in opposite directions past each other simultaneously, and means including adjustable dogs actuated by one of the tables to operate the mechanism and reverse the direction of movement of both tables.

Centerless grinding. GEORGE W. BINNS, WALTER D. ARCHEA, AND LESTER F. NENNINGER. U. S. 1,804,197, May 5, 1931. The combination with a centerless grinder, including opposed grinding and regulating wheels forming a work-receiving throat, a work support within the throat, and means for causing a relative movement of one of the wheels to vary the width of the throat, the means including a driven cam, a rock lever operated by the cam, and means for varying the amplitude of the grinding throat variation for the same arc of movement of the rock lever.

Grinding machine. WALDO J. GUILD. U. S. 1,804,414, May 12, 1931.

Automatic feeder for centerless grinders. JOHN M. KOCH. U. S. 1,804,422, May 12, 1931. In an automatic feeding device for centerless grinding machines, the

combination with feed rolls, of means to deliver rods to be ground to the rolls, means to control the delivering means by the movement of the rods through the grinding machine, the feed rolls being adapted to move the rods into engagement with the grinding machine, and means to render the feed rolls inoperative when the rods become engaged by the grinding machine.

Grinding machine. EDWARD M. TAYLOR. U. S. 1,805,056, May 12, 1931.

Shaping surfaces by grinding. J. A. MOORE. Brit. 345,897, April 9, 1931.

Art and Archaeology

Decorative value of modern table glass. JULIET AND FLORENCE CLARKE. *Arts & Dec.*, **34** [6], 34–36 (1931).—The development of glass is traced with a description of many modern pieces. Illustrated. E.B.H.

Silvered glass. ANON. *Crockery & Glass Jour.*, **109** [4], 30 (1931).—Silvered glass is being stressed in vases, mirrors, etc. E.P.R.

Early 19th Century American glass. WALTER RENDELL STOREY. *New York Times; Amer. Glass Rev.*, **50** [30], 20 (1931).—Early 19th Century American glass is being sought in entire table services. One glass table set is black, ornamented on the edges with a pierced pattern. This is Sandwich glass. Another attractive set has a tulip pattern, the long petals forming the sides of goblets and other dishes. Lacy or lace glass originated in the Sandwich works around 1830. See also *Ceram. Abs.*, **10** [5], 323 (1931). E.P.R.

Stiegel vase. ANON. *Amer. Glass Rev.;* **50** [31], 22 (1931).—The sale of the George S. McKearin collection of early American glass at the American Art Assn., Anderson Galleries, Inc., brought $12,449.50. A paneled Stiegel deep sapphire-blue glass vase from the Herbert Lawton collection sold for $925, and a Stiegel clear amethyst glass perfume bottle, daisy design, for $650. E.P.R.

American and European decorative arts. RUTH RALSTON. *Bull. Met. Mus. Art*, **26** [2], 31–38 (1931).—Included in the anonymous gift of a collection of American and European decorative arts is a representative array of American glass. This comprises pieces of the South Jersey type, plain or with molded decoration, colored glass by Stiegel and his contemporaries, examples of three-mold pressed glass, and some later glass associated with the Sandwich factory products. A.A.A.

Ancient glassware exhibited. ANON. *Amer. Glass Rev.*, **50** [28], 16 (1931).—A collection of rare glassware, bronze, and jewelry, excavated in Egypt, Palestine, and other countries by Azez Khayat, was placed on exhibition and sale on April 6, at the American Art Assn., Anderson Galleries, Inc., New York. A Saracenic sapphire cameo glass pitcher, said to be the only one of its kind ever found, is about 8 in. high with dashes of emerald green on its blue iridescence and is valued at $7500. It was unearthed recently near Aleppo. A rare Hebrew hexagonal bottle of purplish brown, decorated with pressed glass symbols, comes from near Hebron. A ushabti of the 4th dynasty, made before the use of molds was known, is included in the collection. There is another green ushabti engraved with hieroglyphics. Iridescent glass beads in varying sizes make up a necklace in flaming colors. A string of pale cornelian gnostic beads has a series of talismanic lines in white drawn on their surfaces. A string of root of emerald beads is strung with lulu beads, with a layer of gold between two layers of glass, and large cut crystal beads from about 1000 B.C. E.P.R.

English and Irish glass. C. LOUISE AVERY. *Bull. Met. Mus. Art*, **26** [2], 39–40 (1931).—The collection of American and European decorative arts also includes a large group of English and Irish glass dating from the late 18th and early 19th Centuries. A.A.A.

Modern Swedish glass. MABEL DEBRA KING. *Design*, **32** [10], 224–26 (1931).—

Swedish glass in its two classes, the thin etched and the heavier pressed, has assumed outstanding position in the world market today. On the four sides of the pressed Evangelist vase are heads of Matthew (business) carried out in vertical rhythms, Mark (phlegmatic) horizontal, Luke (physician) curved diagonals, and John (aesthetic) crossed diagonals. Descriptions and illustrations of many pieces are given. E.B.H.

China tableware. JAMES BELSHAW. *Arts & Dec.*, **34** [6], 58–59 (1931).—Pieces, sets, and table arrangements are described. Illustrated. E.B.H.

New trends in tableware. ANON. *Christian Sci. Mon.*, **23** [138], 6 (1931).—The trend in table china is away from ornateness and toward simplicity, durability, practicality, and a fundamental rightness of shape and decorative design. New shapes and decorations are described. E.J.V.

Ceramic ware in N. Y. market. ANON. *Crockery & Glass Jour.*, **109** [4], 24–25 (1931).—Kitchen ware is being displayed in a yellow glaze as the background for a red poppy and green leaf treatment, a black silhouette design with a blue poppy and green leaves, and a red columbine with black leaves and black line. "New Yorker" glassware uses the skyscraper as its motif. The buildings are decorated in gray and black while bands of gray, black, and white emphasize the design. Marlborough is made in ivory body with an ivory-stained glaze. An old Sheffield silver pattern was used for the shape. E.P.R.

Salem pottery. HELEN ROBERTSON. *Cleveland Plain Dealer*, Vol. 90, No. 123 (1931).—The heirloom dinnerware produced by the Salem China Co. has the shape and rope edge of old English dinnerware and the design is a copy of a painting by Coutts, an English potter of 150 years ago. This is an underglaze decorated ware. The application of the pattern is explained. Illustrated. E.J.V.

New porcelain. H. F. M. *Kunst.*, pp. 119–21 (Feb., 1931).—F. Fleischman first expressed modern design in porcelain. Pure white, without decoration, is favored for everyday ware. (*D.I.*)

The stage in porcelain. FRANK DAVIS. *Illus. London News*, **178**, 110 (1931).—Early porcelain figures of actors and actresses (Garrick, etc.) are described. H.H.S.

Portrait pieces of early English pottery. ANON. *Illus. London News*, **178**, 209 (1931).—Eleven photographs of pottery portraying Charles I, Charles II, the Duke of Marlborough, and other historical persons are presented. H.H.S.

Precious stones from an oven. GEORGE BIESENTHAL. *Chem. News*, **142** [3703], 212–13 (1931).—A description is given of the precious-stone factory in Bitterfeld. G.R.S.

Lenox lighting fixtures on liner. ANON. *Ceram. Age*, **17** [2], 98 (1931).—The installation of Lenox Belleek fixtures on a new export liner is described. R.G.M.

Sprayed metal coating for clay products. ANON. *Ceram. Age*, **17** [1], 17–20 (1931).—Metal in wire form is melted and sprayed on widely differing substances as metal, wood, glass, porcelain, paper, concrete, plaster, etc. This device has proved commercially serviceable. The sprayed metal coatings may be turned, ground, filed, milled, shaped, or polished. The metal wire feeds automatically through an oxy-acetylene flame. It consumes about 15 cu. ft. of acetylene and oxygen per hour and 50 cu. ft. (at 50 lb./sq. in.) of compressed air per min. The spray covers a circle of about 2 in. in diameter on a surface 5 in. from the nozzle. Generally, the nozzle is held about 4 in. from the surface. The temperature of the surface rises but slightly and it is possible to apply the coating on the most delicate objects. The tool is being used for spraying fused quartz in building up large lenses. Freezing and thawing tests have indicated that no differential expansion occurs which might affect the durability of the coating. Charges for coating vary between 10 and 25¢ per sq. ft. for the material and a labor cost which varies with the cleaning and polishing requirements. It is pos-

sible to reheat the metal below its melting point for decorating purposes. The coating may be built up to any thickness within reason. R.G.M.

Electrolytic deposits of metals on porcelain. F. DOBROVOSKY. *Keram. Rund.*, **38**, 449–51 (1930).—Electrolytic deposits of metal on porcelain insulators are often made over a conducting base coat, usually a mixture of graphite with a small amount of petroleum. The porcelain insulator must be unglazed and the surface must be clean. Graphite base coats are better than metallic coats, although poorer conductors, because they give a smooth flat surface. The base coat must fill all surface pores and cracks and be without imperfections. To get a uniform coating of metal in the electrolytic bath the current distribution over the surface of the insulator must be uniform. Rough base coats produce nonuniform current distribution. H.I.

Theodore M. Davis bequest. I. Objects of Egyptian art. AMBROSE LANSING. *Bull. Met. Mus. Art* [Section II], **26** [3], 4–7 (1931).—Included in the bequest are a group in blue faience of miniature models of funerary equipment, and from the tomb of Thutmosĕ IV, a mass of faience vessels and amuletic signs. These are a brilliant blue and decoration is carried out in black under the glaze. A vase of polychrome glass from this tomb is one of the documents by which the development of polychrome glass technique can be traced and by which its stage can be fixed. The collection is notable for a number of vases in polychrome glass dating from the period of the Empire and some examples representative of the revival of this glass during the 26th and succeeding dynasties. **II. Objects of classical art.** G. M. A. RICHTER. *Ibid.*, **26** [3], 13 (1931).—The collection includes four Greek vases from the 7th to the 4th Centuries B.C., a Corinthian aryballos with a decoration of two lions, an early black-figured lekythos, a red-figured hydria with a scene of an Athenian lady at home, and a large black-glazed Apulian hydria. There are also sixteen important examples of Roman glass. **III. Near Eastern decorative arts.** JOSEPH M. UPTON. *Ibid.*, **26** [3], 31–32 (1931).—Pottery produced in Rakka and Sultanabad from the 12th to the 14th Centuries is represented. A Turkish lamp suspended by a wrought iron chain is typical of the so-called Damascus ware. There are two jars of Gombrūn ware of the 18th Century and a large group of "Kubatcha" ware. All of these have a transparent cobalt blue glaze with black underglaze decoration. There are also specimens of pressed and enameled glass. See also *Ceram. Abs.*, **10** [3], 169 (1931). A.A.A.

Ceramic sculpture of Vally Wieselthier. FRANK CROWINSHIELD. *Design*, **32** [11], 259 (1931).—W. is bringing about a new orientation of ceramic sculpture, creating figures worked "in the hollow," *i.e.*, from the inside out. Illustrated. See also *Ceram. Abs.*, **9** [3], 152 (1930). E.B.H.

Franz Iskra, ceramist. FRITZ NEMITZ. *Deut. Kunst. & Dekoration*, pp. 352–54 (Feb., 1931).—Franz Iskra introduces a red and black glaze mixed without gold and fired at a low temperature. (*D.I.*)

Field notes. ANON. *Amer. Mag. Art*, **22** [4], 305–306 (1931).—The Denver Art Museum is stressing Indian arts, showing polished black ware with dull black decoration. In London at the Persian exhibition the pottery includes (1) an earthenware bowl with an eagle against a foliated ground (9th to 10th Centuries) loaned by the Art Institute of Chicago, (2) turquoise blue glaze of Tabbagh Collection, Paris (Sultanabad type, 12th Century), and (3) an attractive brown dapple luster lent by Parish Watson of New York. E.B.H.

Traveling exhibitions. L. M. *Amer. Mag. Art*, **22** [3], 227–28 (1931).—The American Federation of Arts is sending out 135 pieces by leading American potters shown first at the rooms of the Society of Arts and Crafts of Boston by whom it was assembled. Its itinerary includes in order, the Toledo Art Museum, Davenport, Iowa, Akron, Ohio, Denton, Texas, and Memphis, Tenn. E.B.H.

Artist tour of potteries. II. ANON. *Pottery Gaz.*, **56** [647], 673 (1931).—The opertaion of the jigger and the process and application of pottery printing or decal are explained. For Part I see *Ceram. Abs.*, **10** [6], 405 (1931). E.J.V.

Psychology of color. ANON. *Ceram. Ind.*, **16** [5], 467–71 (1931).—A chart showing colors which harmonize and colors which do not harmonize is included with a chart of legibility of various colored decorations on backgrounds of another color. W.W.M.

Modern Danish pottery. CARLTON ATHERTON. *Design*, **32** [10], 230–33 (1931).—At the close of the 19th Century the Royal Porcelain plant made a high-fire body, the finest European porcelain. At first, decorated in underglaze, the high fire limited the colors to delicate blue-grays, greens, and browns. Later a body decorated in overglaze and a stoneware second only to porcelain, suited to large pieces and ceramic sculptures, were developed. Another important pottery in Denmark is the Bing & Grondahl. A new impetus was given by the Paris exposition of 1900. The bodies used by both factories are royal in appearance, superior to the Chinese. Illustrated. See also *Ceram. Abs.* **10** [5], 321 (1931). E.B.H.

Staffordshire beginnings. FRANK DAVIS. *Illus. London News*, **178**, 260 (1931).—Reproductions of Astbury, Thomas Toft, and Ralph Wood ware are given. H.H.S.

Decorative effects of Sèvres porcelain of the 18th Century. LAURA LORENSON. *Arts & Dec.*, **35** [1], 44–45 (1931).—Sèvres porcelain is closely associated with the history of France. The Sèvres factory, first at Vincennes, manufactured a white soft-paste porcelain in 1745. This "Porcelaine de France" was difficult and costly but perfect from the standpoint of taking color. Porcelain flowers were for sometime the most remunerative product. Furniture inlaid with porcelain plaques became the fashion. In 1765 the secret of hard paste (the use of kaolin) was discovered by accident. E.B.H.

The French Section of the 20th Salon des Artistes Decorateurs. LOUIS CHERRONET. *Art et Décoration*, pp. 1–4 (July, 1930).—Owing to the fact that the Société des Artistes Decorateurs has exhibited but few pieces in the 20th Salon, there is no individual criticism given on the pieces shown. The names of Jean Besnard, André Hunebelle, Suzanne Lalique, M. Luc Lanel, Mlle. Richard, and Leon Emile Bouchet are mentioned. M.J.G.W.

Dresden china. HELEN ROBERTSON. *Cleveland Plain Dealer*, Vol. 90, No. 123 (1931).—Johann Friedrich Bottger was the first to produce hard-paste porcelain and Dresden china in Europe. In 1708 he successfully produced red stoneware, following with true porcelain in 1709. The Meissen porcelain factory was established in 1710 and the first Meissen china was sold in 1713. The development of this industry is traced. Illustrated. E.J.V.

Illustrations of Mexican tile. ANON. *Design*, **32** [11], 241 (1931).—The use of tile in Mexico is illustrated, including an ancient Mayan brazier. E.B.H.

Functionalism in Swedish arts and crafts. ALMA LUISE OLSON. *Amer. Mag. Art*, **22** [3], 197–206 (1931).—Orrefors remains de luxe. The ceramic section shows most advance in individual pieces designed for living rooms, library, or garden. Wilhelm Kag has many variants of his "argenta" process, a silver ornamentation on soft green surface, and the more distinctive "farsta," a combination of golden brown with gray obtained by frequent firings. Arthur O. Percy has decorated a bluish-gray feldspar faience with platinum. E.B.H.

New industrial arts of the world. ANON. *Arts & Dec.*, **34** [3], 58–59 (1931).—The American Federation of Arts has brought together the varied crafts of two continents with silver, steel, porcelain, glass, bronze, enamels, and fabrics in the lead. This exhibition continues at the Metropolitan Museum of Art until December 28, 1931. Illustrated. E.B.H.

The emerging designer. RICHARD F. BACH. *Bull. Met. Mus. Art*, **25** [10], 220–22 (1930).—This article stresses the growing realization of the importance of the designer in industry. He is essential to business and his rights should be protected as are those of composers and authors. There is a need for training artists effectively without losing the individuality of each one. A.A.A.

Machanalia. RICHARD F. BACH. *Amer. Mag. Art*, **22** [2], 101–102 (1931).—The machine is an economic factor and design is a spiritual necessity, the one to produce the other and make it available in quantity to the mass. E.B.H.

Future of the artist craftsman. MARIE MAY. *Deut. Kunst. & Dekoration*, pp. 343–45 (Feb., 1931). (*D.I.*)

Organized resistance to design piracy. WALDON FAWCETT. *Amer. Dyestuff Reporter*, pp. 139–40 (March 2, 1931); see also *Ceram. Abs.*, **10** [6], 404 (1931). (*D.I.*)

Furnishing and fitting the bathroom. ANON. *Arts & Dec.*, **34** [1], 71–73 (1930).—Descriptions and illustrations of luxurious bathrooms, often combined with dressing rooms are given. Ceramic features include walls of buff tile and ceiling of old ivory ornamental plaster combined with African onyx in red, black, and white, with a sunken tub of colored mosaic; an interesting arrangement of reflecting mirrors with deep pink and black marbles; a tub of terre-verte, marbleized; walls of Doria stone with appearance of antiquity with huge sunken tub of brilliant blue banded with blue and white mosaics and mosaic floor; silver wall tile. Illustrated. E.B.H.

Tanagra statuette. GISELA M. A. RICHTER. *Bull. Met. Mus. Art*, **26** [1], 18–20 (1931).—Mrs. Sadie Adler May has presented to the Museum one of the finest Tanagra statuettes in existence. It is a terra cotta figure 12 in. high and represents a young woman gracefully and fashionably dressed in a tunic and mantle with a pointed hat. The colors, originally bright and rich, are now faded. Rose, blue, red, orange, and pink were applied on a white engobe, and were more delicate in tint than if put directly on the terra cotta. The figure is a good example of the rendering of drapery in Greek art and may be assigned to the late 4th or early 3rd Century B.C. A.A.A.

Recent gift of Near Eastern art. M. S. DIMAND. *Bull. Met. Mus. Art*, **26** [1], 6–12 (1931).—Objects dating from the 3rd to the 15th Century include stucco panels from a Sasanian palace at Nizanabad, ceramics, sculpture, metal work, wood carving, glass objects, and printed cottons. An unglazed ovoid vase of the Sasanian period (200 to 640 A.D.) was found at Takrit, in Irak. Its stamped decoration consists of a bird attacking another. Many fragments of unglazed ceramics, which may be assigned to either Sasanian or early Mohammedan period have come from this vicinity. The decorative motives consist of birds, animals, and crosses. Complete vases of this period are rare; only one other is known, which is in the British Museum. A notable example of Persian ceramic art is a bowl with an overglaze decoration found at Rhages. The interior is decorated with green splashes over a white opaque glaze, and has a Kufic inscription in blue. This type of ceramics has also come from excavations in Susa and Samarra. Another Persian bowl, found at Amol, belongs to the Gabry type, chiefly known from finds at Hamadan and Zendjan. The design, engraved and painted in green, consists of a large and a small bird. Two interesting examples of Persian ceramic art are an engraved ewer and an unglazed pilgrim bottle, found at Saveh. The ewer, dating from the 10th or 11th Century, is decorated in the barbotine technique, well known from Mesopotamian pottery. The pilgrim bottle has a molded decoration in relief. Pottery of this kind has also been found in Syria and Mesopotamia and may be attributed to the 11th or 12th Century. A small 13th Century Persian jug has arabesques painted with a thick cobalt blue glaze, the body being left unglazed. A bowl found at Saveh is also from the 13th Century. Three fragments of Fatimid glass with lustered decoration, found at Fustat, belong to the early Mameluke period (13th or

14th Century). It is of coarse earthenware and shows arabesque design in brown and green under creamy transparent glaze. A.A.A.

Achaeminid art of Persia. STANLEY CASSON. *Discovery*, **12**, 49–52 (1931).—C. deals with a phase of Persian art of the 6th and 5th Centuries B.C. H.H.S.

Tomb excavations at Corinth, 1930. I. JOSEPHINE PLATNER. *Art & Archaeology*, **31** [3], 153–60 (1931).—Excavations were made in the North Cemetery outside the city walls. In the deepest deposits potsherds of neolithic pottery (2500 B.C.) were unearthed, showing simple linear design which persisted through the régime of the early and middle Helladic invaders. Urfirnis pottery is a highly burnished ware with a sepia-brown wash decorated with incisions. A deep well in the North Cemetery yielded almost 50 early Helladic vases, a few intact. One most in vogue, of Cycladic origin, but not outliving the early Helladic period was the sauce boat, a gourd-shaped vessel with a curious long spout having a winglike projection which insures pouring liquids without a drip. In the middle Helladic (2000–1600 B.C.), the Matt Malerei eclipsed the Urfirnis. Then came the Minyan supremacy, producing a Minyan ware, wheel-made, with a silver-gray color due to the reduction of iron oxides in the clay. The late Helladic shows a strong Cretan influence. Throughout the Mycenaean and Dorian periods pottery is the best clue to their culture. Descriptions and illustrations of many vases and jugs are given. **II.** *Ibid.*, **21** [4], 225–34 (1931).—The variety of pottery found at Corinth proves that city a center of ceramic manufacture. The Corinthian geometric vases are superior in technique and simple and precise in decoration. The finding of gray Lydian vases having black-striped decoration, squat, with a conical base, and made of mica-flecked clay evidences commercial relations between Corinth and Sardis. Athens in the 6th Century invaded the Corinth ceramic field. Corinth used buff clay and ivory slip decorated in rich colors but the Athenians secured the finest known artists and so excelled that the Corinthian work deteriorated into cheap inferior ware. Illustrated. See also *Ceram. Abs.*, **9** [7], 498 (1930). E.B.H.

Thermi, Mytilene. WINIFRED LAMB. *Illus. London News*, **178**, 266 (1931).—Thermi, excavated by the British School at Athens, so closely resembles Troy that it clears up problems of Trojan archaeology. H.H.S.

Jericho excavated. JOHN GARSTANG. *Illus. London News*, **178**, 94–97 (1931).—Diagrams and photographs. H.H.S.

Discoveries at Ur. C. L. WOOLLEY. *Illus. London News*, **178**, 202–204 (1931).—The 9th year of excavations at Ur has unearthed magnificent buildings of 2250 B.C., the burial place of the 3rd dynasty of kings of Ur, and in a private house the statue of a goddess, Pa-Sag, whose function it was to protect travelers on desert wastes. See also *Ceram. Abs.*, **9** [1], 13; [12], 1009 (1930). H.H.S.

New script from ancient Syria. C. J. GADD. *Discovery*, **12**, 42–45 (1931).—Cuneiform clay tablets with alphabetical script dating from 1300 B.C. were found at Ras Shamra together with a wealth of pottery, Cypriote, Egyptian, Mycenaean, and native. H.H.S.

BOOKS

Roman Pottery at Throlam Holme-on-Spalding Moor, East Yorkshire. PHILIP CORDER. Introduction by T. Sheppard. 41 pp. A. Brown & Sons, Hull, 1931. Price 3s. Reviewed in *Times Lit. Supp.*, **30**, 117 (1931).—A report of the Roman Antiquities Committee of the Yorkshire Archaeological Society is presented. H.H.S.

Agrigentum: Topography and Arts. (Italian.) PIRRO MARCONI. Vallecchi, Florence, 1930. Reviewed in *Times Lit. Supp.*, **30**, 71, (1931).—One of the most beautiful cities of the ancient world, Agrigentum (Greek, Akragas), in Sicily has been excavated and restored by funds provided by Alexander Hardcastle. See also *Ceram. Abs.*, **9** [12], 1009 (1930). H.H.S.

PATENTS

Making imitation leaded glass. KALMAN WARGA. U. S. 1,800,763, April 14, 1931. The method of making imitation leaded glass which consists in first printing on a glass surface plane lines in imitation of the leaden strips of a leaded glass object, the chief ingredient of the lines consisting of a powdered siliceous substance mixed with a liquid binder and flux, then coloring the various areas of the surface intermediate the lines by successive stencil transfers, the lines and the colors each containing a mineral pigment and a vitreous binding material combined to fuse at the same temperature, and then heating the glass to irremovably fix the lines and colors to the surface of the glass at substantially the same temperature.

Making ornamental mirrors. GEORGE F. AND WILLIAM H. COLBERT. U. S. 1,802,168, April 21, 1931. A process of forming a decorative reflective article, which consists in covering the face of a transparent glass sheet with a metallic film precipitated from a solution, coating the film with a photosensitive emulsion, exposing portions of the coating to the action of light, developing the exposed portions to form a pattern so that one part of the coating is subject to the action of a solvent and the remaining part is not subject to such action, applying solvent to remove the soluble part of the coating, and the underlying parts of the film, and then applying a backing of a color contrasting to that of the film over the entire surface of the sheet carrying the film.

Ornamental composite glass. GEORGE F. AND WILLIAM H. COLBERT. U. S. 1,802,169, April 21, 1931. An ornamental composite plate comprising a transparent sheet of glass having on one surface a deposited metallic film partly covering the surface and constituting an ornamental pattern, and a reinforcing backing of hard impervious material coextensive in area with the glass sheet cemented to the rear surface thereof and of a color contrasting to that of the film.

Ornamental composite glass. GEORGE F. AND WILLIAM H. COLBERT. U. S. 1,802,170, April 21, 1931. A plate of composite material comprising a front sheet of glass, a back sheet of glass, an interposed layer of reinforcing material secured to both sheets and comprising a plurality of sections of different colors arranged to give an ornamental appearance, and a band of relatively opaque material on the rear face of the front sheet of glass to overlie and conceal the joint between the two sections of reinforcing.

Design for plate, etc. EDGAR M. BOTTOME. U. S. 83,893, April 14, 1931.

Design for bottle. ROBERT L. ASTE. U. S. 83,892, April 14, 1931.

Design for sugar bowl, etc. JEDDIA B. CLARK. U. S. 83,895, April 14, 1931.

Design for dish, etc. WILLIAM P. GRAHAM. U. S. 83,899, April 14, 1931.

Design for pedestal for lavatory basin. GEORGE SAKIER. U. S. 83,922, April 14, 1931.

Design for faucet. GEORGE SAKIER. U. S. 83,923, April 14, 1931.

Design for lavatory. ROY H. ZINKIL. U. S. 84,065, April 28, 1931.

Making decalcomania. ALPHONSE BIHR. U. S. 1,803,836, May 5, 1931. A positive decalcomania transfer comprising a layer of paper, a layer of adhesive substance on the paper, a layer of lacquer on the face of the adhesive layer, and a design or lettering in bold relief constituted of material fused upon the lacquer.

Cement, Lime, and Plaster

Researches on the rotary kiln in cement manufacture. XVI. Entropy of Portland cement formation. GEOFFREY MARTIN. *Rock Prod.*, **34** [8], 54–57 (1931).—M. outlines the theory of heat utilization in chemical reactions such as the formation of Portland cement clinker. He points out how most so-called heat balances of cement kilns are valueless because only the amount of heat units is taken into consideration.

whereas the temperature or thermal pressure should also be considered, since various reactions require certain temperatures or thermal pressures. The theory and mathematics of entropy as developed and applied to steam engines and boilers has been applied by M. to the manufacture of Portland cement, insofar as the necessary fundamental data are known. Tables of heat absorption and entropy changes which occur in raising raw material for 1 lb. of clinker from 32°F to the clinkering temperature of 2498°F are given. **XVII. Preheating entering air by hot clinker.** *Ibid.*, **34** [9], 49–52 (1931).—M. treats the necessity of preheating all the air possible for combustion to the highest possible temperature. Some 15% of the air for combustion enters the kiln practically cold with the powdered fuel. The highest temperature to which it is possible to preheat the air from the cooling clinker is 2500°F. Under certain conditions the efficiency in the ideal kiln is increased by heating an excess of the air actually needed for combustion to 2500°F. In modern practice, however, because of the heat transferring inefficiency of the clinker cooler, it is not possible to preheat the air to much above 900°F. The average temperature attained in practice probably does not exceed 400°F. Tables and data on preheating of air are presented. **XVIII.** *Ibid.*, **34** [10], 54–57 (1931).—Proof is given that the clinker output per 1 lb. of coal burned is greatest when the flame temperature is highest, and that the output of clinker must diminish when air in excess of 10.478 lb. per 1 lb. of standard coal is supplied to the kiln. M. proves thermodynamically and mathematically the preceding statement. The analysis is for an ideal condition not attained in practice. The point is emphasized that unless flame temperatures can be increased the limits set to kiln economy are narrow, but there are practical limits to the increase in flame temperature which M. points out. Kiln design should be directed toward supplying as much high-grade heat as possible to the clinkering and decarbonating zones. For Parts XIV and XV see *Ceram. Abs.*, **10** [6], 450 (1931). W.W.M.

Rotary kilns of cement plants and their rational electric control. E. CARLSSON. *Rev. mat. constr. trav. pub.*, No. 257, pp. 73–78 (1931).—Advantages of electrical control of rotary kilns are as follows: (1) economy of motive power due to abolition of original transmission device of mediocre quality, (2) reduction in space required, (3) expense of lubrication reduced, (4) no expense for maintenance and supervision, (5) ease of regulating speed within large limits, (6) protection of motor and gears in cast-iron casing eliminating all damage of mechanical nature in installation, and (7) elimination of accidents by enclosing all machinery. M.Y.H.

Manufacture of Portland cement from raw materials and fuels high in sulphur content. ALTON J. BLANK. *Rock Prod.*, **34** [8], 64–65 (1931).—B. concludes that the sulphur present as a sulphide causes unsoundness in cements of a much more dangerous character than unsoundness caused by free lime. W.W.M.

Significance of clay for lime fixation in raw cement flour. K. SPANGENBERG. *Zement*, **20** [5], 94–96 (1931); *Rock Prod.*, **34** [9], 98 (1931).—S. reviews the conclusions relative to researches on alite as reached by Bates, Klein, Phillips, Kühl, Jänecke, Dyckerhoff, and Guttmann and Gille. The product of calcination of pure kaolin behaves differently than a mixture of the two anhydrous oxides, and the reaction of one with CaO might be different from that of the other. S. plans to examine the reactions of $Al_2O_3 \cdot H_2O$ with $CaCO_3$, the mechanics of which are discussed. These reactions are greatly accelerated by the influence of gases, especially H_2O vapor. W.W.M.

Cement in theory and practice. IV. Problem of hardening and significance in cement research. HANS KÜHL. *Cement & Cement Mfg.*, **4**, 3 (1931).—K. gives a review of the literature on the setting and hardening of Portland cement and presents his theory of the significant reactions involved. For Parts II and III see *Ceram. Abs.*, **10** [6], 408 (1931). W.L.

Strength and fine grinding of cement. A. B. HELBIG. *Zement*, **20** [4], 275–78 (1931); *Rock Prod.*, **34** [10], 90 (1931).—H. states that the finer cement is ground, the stronger it will be, especially on short-period tests. He describes the grinding plan in a plant which extracts the ultra-fine Portland cement which is used as an early high-strength cement. The nature of operation of grinding media is also discussed. W.W.M.

Magnesian raw material in cement manufacture. WALTER MARSCHNER. *Zement*, **20** [3], 265–66 (1931); *Pit & Quarry*, **22** [3], 73 (1931).—High magnesia content in sintered Portland cement has a damaging effect on soundness and the German specifications limit the magnesia content to 5%. If the raw material has a hydraulic modulus of at least 1.9, magnesia prevents a part of the lime from combining with the acids. If the temperature is raised beyond 1450° and left at this temperature at least 20 minutes, the excess lime drives the magnesia out of combination, producing a hard, blue-green clinker which shows no unsoundness in storage. If the hydraulic modulus lies below 1.8, cellite is formed and the clinker production is not sound. If the magnesia is present as magnesium silicate (as when blast-furnace slag is used) a stable clinker equivalent to Portland cement in color and specific gravity is produced with a hydraulic modulus below 1.8, at temperatures of 1200 to 1400°. This clinker has not quite the strength of Portland cement. Such methods of firing completely eliminate the injurious action of the magnesia and the cement produced corresponds and even exceeds the standard specifications for Portland cement. E.P.R.

Gypsum and gypsum products manufacture. IX. Manufacture of Keene's cement. S. G. MCANALLY. *Rock Prod.*, **34** [8], 47–49 (1931).—McA. describes the manufacture of Keene's cement. Gypsum, in lumps from 6 to 10 inches in size, is stacked in periodic kilns and fired to 1250°F in several days, allowed to cool, and ground till 90 to 95% passes a 200- mesh sieve. One or more chemicals are mixed with the pulverized calcine to improve the set and hardness; dehydrated alum, potassium and sodium sulphates, and borax are used. The effect of these chemicals is shown by some experimental data on mixtures of Keen's cement (without added chemicals) and single-boil, double-boil, and raw gypsum. Keene's cement does not heat when mixed with water, nor does it deteriorate with age. Its tensile strength at various stages is given. Anhydrite is discussed and McA. gives two formulas for cements made from pulverized uncalcined anhydrite. For Part VIII see *Ceram. Abs.*, **10** [6], 410 (1931). W.W.M.

Effect on concrete of acid water from stored bituminous coal. E. F. WOLF. *Ind. Eng. Chem.*, **21** [10], 908–10 (1929); *Colliery Guard.*, **141** [3630], 308 (1930).—W. found that when this acid water first comes into contact with dense concrete a comparatively rapid erosion takes place and an insoluble film is precipitated which retards the action. The corrosion during 28 months is of no serious consequence. Limestone is ineffective in neutralizing this acid. R.G.M.

Cement factory of International Cement Co. ANON. *Rev. mat. constr. trav. pub.*, No. 257, pp. 60–65 (1931).—The Lone Star Cement Co. has a capacity of 1,000,000 barrels per year. It is situated within the city and has an efficient smoke consumer. Mixing and grinding of materials and machinery used, the cooling, sacking, and storing of the cement, and the kilns, reservoir, oil pump, electric generator, and transformers are described. Heavy oil is used instead of pulverized coal. M.Y.H.

Cement industry in Great Britain in last 25 years. A. MERCIOT. *Rev. mat. constr. trav. pub.*, No. 257, pp. 57–60 (1931).—White, colored, quick-setting and super cements are manufactured. Great expansion of the industry is due to the formation of companies for marketing and distribution. M.Y.H.

Enameling. I. Historical development and physico-chemical principles. L. STUCKERT. *Ceram. Age*, **17** [2], 61–70 (1931).—S. traces the development of enameling

Enamels

from its origin to the present day and cites production figures. A table shows the relations between glass batches of the silicate industries, *i.e.*, glass, enamels, and glazes. The physical chemistry of simple substances and 2-, 3-, and 4-component systems are discussed with the nature of the glass phase. Typical diagrams and curves are included. II. *Ibid.*, **17** [3], 135–67 (1931).—S. discusses the physical and chemical properties of enamels as related to plant production problems. Tables of oxide factors and compositions are included. Bibliography. R.G.M.

Testing enameled articles. ERNST FRANKE. *Keram. Rund.*, **38**, 247–49 (1930).—The toughness of the enamel coat and the tendency to pop off due to blistering is tested by the use of a machine which drops a stream of small steel balls, about 3 mm. in diameter, on the enameled surface from a known but variable height. The results of a few tests on enameled signs are given. It is concluded that the apparatus has possibilities for testing enameled ware. H.I.

White enamels without cryolite. ANON. *Keram. Rund.*, **38**, 280–84 (1930).—Experiments show that fluorspar, kaolin, and soda ash could be substituted for the more expensive cryolite, thus reducing the price and giving the same opacifying power. The content of lime and soda in the modified enamel was increased, the content of silica decreased, and the physical properties of the cryolite-free enamel were somewhat improved over the original enamel. H.I.

Opacity of enamels in terms of colors. R. E. STARK. *Jour. Amer. Ceram. Soc.*, **14** [6], 457–59 (1931); for abstract see *Ceram. Abs.*, **9** [3], 162 (1930).

Milling, application, and firing of ground-coat enamels. H. L. COOK. *Better Enameling*, **2** [3], 10–13 (1931).—The problem of suspension, the effect of grinding and aging, the addition of borax, the size of grinding pebbles used, the water content, screening and dipping, and the use of old enamel after shut-downs are discussed. W.C.O.W.

Drying and firing ground-coat wet-process enamels. ANON. *Better Enameling*, **2** [3], 14–20 (1931). W.C.O.W.

Efficient application of ground coat. FRED MCC. BURT. *Ceram. Ind.*, **16** [5], 443–44 (1931).—B. discusses the properties and functions of ground-coat enamels for cast and sheet irons. He considers the factors affecting adherence and application of the coat. The ground-coat enamel has a lower coefficient of expansion than the metal base and for this reason the latter must be properly prepared and cleaned to aid the adherence. Dipping small close-mouthed pieces of ware requires skillful operators. Dipping of various articles and the necessary condition of the enamel slip are described. Ground-coat enamels must be dried immediately to avoid development of rough spots. Several drying methods are given. Drying must not be too fast or cracking will result. The ground coat should require a higher firing temperature than the cover-coat enamel. Some ware, such as mottled kitchen ware, is covered with only one coat of enamel. W.W.M.

Spraying finish coat on cast-iron enamels. ANON. *Better Enameling*, **2** [4], 8–20 (1931).—The equipment necessary, the method of checking the consistency of the enamel, the preparation of the castings, and the spraying of the castings are described. W.C.O.W.

Sodium metasilicate as an industrial alkali. JAMES G. VAIL. *Metal Cleaning & Finishing*, **3** [4], 332 (1931); see also *Ceram. Abs.*, **10** [4], 302 and 309 (1931). E.J.V.

Sandblasting for vitreous enameling. MATTHEW W. BUTLER. *Metal Cleaning & Finishing*, **3** [4], 335–38 (1931).—A discussion of the methods, equipment, and materials for the sandblasting of metal bases for vitreous enamels is presented. Illustrated. See also *Ceram. Abs.*, **10** [6], 412 (1931). E.J.V.

Pickling of pipe with commercial inhibitors. E. L. CHAPPELL AND P. C. ELY. *Ind. Eng. Chem.*, **22** [11], 1201–1203 (1930). R.G.M.

Solution of scale in pickling steel. E. L. CHAPPELL AND P. C. ELY. *Ind. Eng. Chem.*, **22** [11], 1200–1201 (1930). R.G.M.

Composition and uses of heavy-duty metal cleaners. C. L. MANTELL. *Metal Cleaning & Finishing*, **3** [4], 305–306 (1931).—The various constituents which enter into the composition of heavy-duty metal cleaners, their value as detergents, cost considerations, and other points are discussed. E.J.V.

Equipment for cleaning metal. IV. R. W. MITCHELL. *Metal Cleaning & Finishing*, **3** [4], 287–94 (1931).—Data are presented on such subjects as tank location and design, drainage systems, siphons, overflow dams, ventilators, tank covers, etc. Illustrated. For Parts I, II, and III see *Ceram. Abs.*, **10** [6], 413 (1931). E.J.V.

Firing tools for porcelain enameling. ANON. *Better Enameling*, **2** [4], 25–29 (1931).—Nickel-chromium alloys are the most satisfactory from the standpoints of weight, strength, and freedom from warping and scaling. The design of the tools is important and several illustrations are given showing the proper design for different types of ware. To effect an economy in fuel the pay load should weigh several times as much as the firing tools. In one of the country's large refrigerator plants this ratio of weight of ware to weight of firing tools is five to one. W.C.O.W.

BULLETINS

Effect of smelter atmospheres on quality of dry-process enamels for cast iron. A. I. ANDREWS AND H. W. ALEXANDER. Univ. of Ill., Eng. Expt. Sta., *Bull.*, No. 227, 1931. Price 10¢. Dry-process enamels were subjected to the following smelter atmospheres: (1) sulphur dioxide, (2) sulphur dioxide and reducing conditions, and (3) reducing conditions. The effect of these atmospheres on the quality of the enamel after it had been fired on the cast-iron test pieces was determined. General conclusions drawn from the investigations are as follows: (1) Composition plays an important part in the resistance of dry-process enamels for cast iron to the effect of reducing smelter atmospheres and reducing smelter atmospheres with SO_2 present. The leadless tin enamel is the most resistant to the reducing conditions. The high-lead enamel is less resistant than the low-lead enamel to reducing conditions and reducing conditions with SO_2 present. It should be possible to develop leadless enamels that would be resistant to any reducing conditions found in plant smelting practice. Tin oxide is less readily reduced than antimony oxide. (2) Careful quenching and washing will remove the sulphate formed by smelting in the presence of high percentages of SO_2, and no scumming or sulphur pock marks will result from that source. Any sulphate formed from the sulphur dioxide in fuels used in regular plant smelting practice should be removed by the regular water-quenching practice. Careful quenching and washing are advisable in all cases. (3) Since, in this investigation, only gases in high concentrations caused defects to appear, it is probable that many of the black specks encountered in commercial smelting are due to carbon or other foreign materials being trapped in the enamel. A.A.

Tests on electric arc-welded lap joints. R. P. DAVIS AND L. V. CARPENTER. West Virginia Univ. Coll. of Eng., *Research Bull.*, No. 7, Series 16, No. 2 (November, 1930). E.C.C.

PATENTS

Enameled metal top for tables, etc. FREDERICK GEIGER. U. S. 1,800,343, April 14, 1931. A table top, etc., of sheet metal having a marginal flange beneath, thrust strips within the flange at opposed sides, and permanently retained means for adjustably

tensioning the top, the means including an extensor between the strips comprising a bar, and an extensor screw bearing between plates at the end of the bar and the edge of the adjacent thrust strip.

Oven rack. FRANK CARAMELLA. U. S. 1,802,234, April 21, 1931.

Enamelware. OSCAR HOMMEL. U. S. 1,805,143, May 12, 1931. The method herein described of coating iron and steel articles with vitreous enamel which consists in applying to the surface of the article an initial coating of a jelly containing a solution of a salt of a metal of the iron group, applying to the initially coated surface a vitreous material, and firing the so-prepared article.

Glass

Direct determination of soda in soda-lime glasses by precipitation as uranyl zinc sodium acetate. FRANCIS W. GLAZE. *Jour. Amer. Ceram. Soc.*, **14** [6], 450–53 (1931).

Selenium dioxide as a constituent of glasses. LOUIS NAVIAS AND JOHN GALLUP. *Jour. Amer. Ceram. Soc.*, **14** [6], 441–49 (1931).

Propagation of fissures in glass and other bodies with special reference to the split-wave front. F. W. PRESTON. *Jour. Amer. Ceram. Soc.*, **14** [6], 419–27 (1931).

Impact modulus of glass. F. W. PRESTON. *Jour. Amer. Ceram. Soc.*, **14** [6], 428–31 (1931).

Brief analysis of recent data on impact strength of glass. F. W. PRESTON. *Jour. Amer. Ceram. Soc.*, **14** [6], 432–34 (1931).

Stresses in wire glass due to the wire. F. W. PRESTON. *Jour. Amer. Ceram. Soc.*, **14** [6], 435–40 (1931).

Diphasic nature of glass. F. W. PRESTON. *Jour. Soc. Glass Tech.*, **14** [56], 349–50 (1930).—P. offers an explanation for some unusual cases of double refraction in specimens of glasses. G.R.S.

Devitrification diagrams in terms of batch mixtures. F. W. PRESTON. *Glass Ind.*, **12** [5], 97–98 (1931).—P. makes available, in simple form, the scientific work of Morey on the conditions and readiness with which glass devitrifies. The Morey diagram for the soda-lime silica system is redrawn on the basis of commercial batch mixtures with an inclined network of lines indicating the weight of lime and soda ash used to 1000 lb. of sand. This network covers the whole range of commercial soda-lime glasses, but in order that the diagrams be strictly applicable, it is necessary that the glass be a straight soda-lime-silica glass. The application of this diagram for the forecasting of the glass' liability to devitrification is explained. Illustrated. E.J.V.

Inhomogeneity of glass. F. W. PRESTON. *Glass Ind.*, **12** [5], 110 (1931).—A large part of the troubles in working glass are due to its inhomogeneity. Inhomogeneous glass is variously called "cordy," "reamy," or "lappy," and the defect is also known as "striae," "veins," etc. More attention should be paid to getting homogeneous glass out of tanks. E.J.V.

Crystallization in glass. H. H. BLAU. *Glass Ind.*, **12** [5], 110–11 (1931).—In discussing crystallization in glass it is pointed out that devitrification is an undesirable form of crystallization, not being under control, while in opal glass there is a production of minute crystallites under controlled conditions to produce the diffusion of light which characterizes this type of glass. E.J.V.

SO_3 content in glass. H. JEBSEN-MARWEDEL AND A. BECKER. *Glastech. Ber.*, **8** [9], 525–29 (1930).—The decrease in SO_3 content of a sulphate-containing standard glass under the influence of different furnace atmospheres was investigated. The varia-

tion determined between oxidizing and reducing atmospheres at six temperatures is shown in shaded areas on diagrams depicting data collected. The SO_3 content is a direct measure for the risk of new bubble formation (late frothing) in the melt. With powerful reduction the SO_3 content can be reduced to zero at 1350°; in an oxidizing atmosphere this result occurs in a definite time at 1500°. The difference in effect of oxidizing and reducing atmospheres depends on the fact that to the thermal decomposition active in both cases there is added a chemical surface reaction under reducing conditions. The reduction occurs over the sulphide stages. The gradient of the SO_3 decrease for a fixed temperature does not remain fixed. It appears to be significantly disconnected from the rate of heating to the testing temperature. If it is great, a "delay in boiling" liberates the SO_3 tension in the glasses suddenly and in greater quantities than is the case with moderate temperature increase. In all the processes described, the retardation phenomena characteristic of all glasses are important. For bubble formation itself, the reaction of sulphides with sulphates is important. All the described relations are applicable to glassmelting furnaces in the industry. E.J.V.

Critical investigation of methods for determination of resistance to chemical attack of glasses. ERNST REXER. *Keram. Rund.*, **38**, 387–90, 421–25, 464–65, 506–507, 546–48, 560–64, 590–93, 624–27 (1930).—The methods now in use for the testing of the attack of water on glass were critically investigated. Methods using crushed, the Mylius "surface," and autoclave samples were tried. The absolute amount of dissolved material depends on (1) type of glass, (2) amount of strain in the glass from which the crushed material is made, (3) quantity and size of the crushed glass, (4) leaching temperature and time, (5) quantity of solution, and (6) position of the grains in the leaching vessel. Between the strain in a piece of glass and the solubility of the crushed material produced from it there appears to be a mechanical relationship such that with increase in strain there is an increase in roughness of the crushed grains and consequently an increase in surface and solubility. There is no direct proportion between the quantity of crushed glass used and the absolute amount of the dissolved material. Larger amounts of crushed glass, finer grain, lower leaching temperature, and shorter leaching time cause an increase in the percentage amount of alkalis in the dissolved material. A small amount of relatively large grains should be used for the best evaluation of a glass by solution. A small range of grain size and a large quantity of crushed material are necessary for the best reproducibility of a series of experiments. The standard methods of the Deutsche Glastechnische Gesellschaft are satisfactory for the determination of the resistance to water attack of crushed material. In the Mylius surface method, a relation was found between solubility and the ratio of capacity to surface of the flask used. With good glasses the solubility dropped slightly with increasing ratio of capacity to surface, while with poor glasses the solubility increased. The effect of cooling the glasses was investigated and it was found that the annealing leer gases and the concentration of the alkalis near the surface had affected the solubility. Inner and outer surfaces of flasks behaved differently due to the method of shaping the flasks. In the investigation of autoclave samples the specific effect of varied methods of attack was determined as well as the specific effect of the shape and method of manufacture. H.I.

Change of equilibrium in glass and effect of prior heat treatment on its physical properties. E. BERGER. *Glastech. Ber.*, **8** [6], 339–67 (1930); *Diamant*, **52** [16], 258 (1930).—Properties of glasses are dependent on the heat treatment, but with a sufficiently long cooling period they assume a final value for each temperature, the same whether a higher or lower property value is exhibited next. These equilibrium values for all properties, which are variable with the temperature coefficient at the transformation point, appear to lie on straight lines of different slopes which come together at

statically fixed transformation points. The rate of change of equilibrium for each temperature can be expressed by the following equation: $\frac{dE}{dz} = C\frac{1}{z}$, where C represents a factor, E the property, and z the time (from the beginning of the test). For preliminary proceedings the lowest cooling time z is regarded as a true constant conformable to this equation, which is necessary for complete equilibrium standardization. The log z value decreases along two lines which intersect at the fixed transformation point with rising temperature. Corresponding equations and relations appear for the rate of grain increase which is exhibited in a cold-worked metal due to isothermal recrystallization. The view according to which a dynamic aggregation of particles is assumed for the interior condition of the glass with falling temperature is thus made more plausible. The production and removal of double refraction, generally indicated as strain, may be traced back to the dynamic aggregation as the cause. The cooling process does not cause the removal of double refraction by the equalization of mechanical strains on account of flow reactions in the glass, but by a uniform equilibrium standardization of the grades of aggregation. This new concept of the cooling process is advanced mathematically and is proved by observations. The manner in which heat treatment affects the properties and their change with temperature in static and dynamic work is shown in figures. It is thus possible to arrange a series of definite results. A brief criticism of the Smekal hypothesis of flaw formation is undertaken on the basis of the results obtained and a view of the thermal and elastic afterworking phenomena is given. See also *Ceram. Abs.*, 10 [5], 335 (1931). E.J.V.

Effect of heat treatment of glasses on their density and chemical stability. HERMANN SALMANG AND KURT V. STOESSER. *Glastech. Ber.*, 8 [8], 463–82 (1930).—This work consists of investigation of the density and leachability of glasses heat treated in different ways. The heat treatment of the glasses was altered with relation to the rate of annealing and the chilling temperature. A new apparatus was built for the chilling of glasses from different temperatures at a practically uniform cooling rate. A process was developed for the chilling effect from different temperatures at different but controllable cooling rates. The determination of the density of the chilled glass samples was facilitated by a special pycnometer method. The accuracy of this method was ± 0.0002. The investigation of density in relation to the chilling temperature was made on soda-lime-silica and lead glasses, determining their density behavior in the temperature range between 1550° and 20.° The results of the investigations were plotted in the form of curves which showed anomalies in the ranges of the transformation and the aggregation of the glasses. The effect of cooling rate from equal chilling temperatures on the specific gravity of a soda-lime-silica glass was studied. Measurements of the index of refraction of chilled glasses showed that with similar cooling conditions the index of refraction is directly proportional to the density of the glasses. In another series of tests the effect of the mechanical strain produced in glass by chilling on the density of the glass was studied. It was ascertained that the effect of mechanical strain produces only a small fraction of the entire change in density caused by chilling. Studies were made with reference to the leachability of differently chilled glasses. A direct relation between leaching value and chilling temperature cannot be observed, as in the range of the aggregation of the glasses the leaching value ranges up to 23%. Differences in cooling rates were distinguished as causes of this scattering of values. From the results it was concluded that for a fixed chilling temperature a linear relationship between cooling rate and leaching value could be assumed. Investigations relative to the effect of cooling rate on the specific gravity of glassy silica led to the result that the fused silica at 1850° has a greater density than cooled silica glass at lower temperatures. For glassy silica at 1850° the density is directly proportional to the cooling rate. It was

assumed that above a definite temperature between 1200° and 1850° the temperature coefficient of cubical expansion of silica glass is negative. The density of silica glass also passes through a minimum value in this temperature range. Extensive tables of data are presented. Illustrated. E.J.V.

Mercury glasses. F. H. ZSCHACKE. *Glastech. Ber.*, **8** [9], 519–25 (1930).—A series of glasses with mercury in the form of mercuric carbonate in amounts of 0.1 and 2.5% were melted under neutral, oxidizing, and reducing conditions. Only a small fraction of the mercuric carbonate introduced into the batch remained in the glass, since the greater part volatilized in melting. The colors in the glass, due to the introduction of mercury, lie between a golden yellow and a blue-green, according to the melting temperature and the reducing or oxidizing means. Strongly reducing means produce a practically colorless glass that becomes tinted with a reddish-brown color on slow cooling. A supplementary heating in reducing atmosphere allows the color to be greatly eliminated. According to ultramicroscopic investigation this elimination can depend on a change in the colloidal division of the submicroscopic particles. According to the findings of the investigation the colors produced in glass can be traced back to a colloidal division of the mercury in any form in the glass. An X-ray examination gave no indication of any crystalline interference figures. Spectroscopic examination showed only a more or less strongly marked end absorption in the ultra-violet which was strongly involved in places in the blue. Band and line spectra could not be observed in any case. In ultra-violet light a discoloration, even if in very small measure, was established in most of the glasses examined. Phosphorescence and fluorescence, on the other hand, were not noted. Corrosion tests on glasses sensitive to silver corrosion showed negative results. E.J.V.

Hygroscopicity and chemical composition of glass. BUATIER DE MONGEOT. *Ind. Silicati*, p. 7 (1930); *Rev. belge ind. verrières*, **1**, 248 (1930–31).—Glass was made into sheets 0.1 m. square and with a thickness of 0.5 cm. M. measured the resistance in megohms between two opposite edges, noting at the same time the temperature and the hygrometric state of the surrounding air. When the alkalis in the glass exceed 14% the glass becomes hygroscopic. Potash is more harmful in this respect than soda. Alumina, within certain limits, counterbalances the effect of the alkalis. Up to 13%, lime resists the hydroscopic tendency of glass. Higher percentages of lime at the expense of silica are harmful. A.J.M.

Effect on the properties of a soda-lime-silica glass of repeated melting in platinum: X-ray pattern. W. E. S. TURNER. *Jour. Soc. Glass Tech.*, **14** [56], 351–53 (1930); for abstract see *Ceram. Abs.*, **10** [2], 107 (1931). G.R.S.

Thermal endurance of glass. W. J. A. WARREN. *Jour. Soc. Glass Tech.*, **14** [56], 313–29 (1930); for abstract see *Ceram. Abs.*, **10** [2], 107 (1931). G.R.S.

Scientific basis of glassmelting. W. E. S. TURNER. *Jour. Soc. Glass Tech.*, **14** [56], 368–93 (1930).—The effect of applying heat to a glass batch results in both physical and chemical changes. Physical changes discussed are (1) thermal changes, (2) melting points of the constituents of glass batches, (3) mutual solubility of glassmaking constituents, and (4) volatilization during glassmelting. Under chemical changes are the following topics: (1) processes of decomposition or dissociation and (2) chemical interactions during the melting process. Problems requiring attention are outlined and new investigations now in progress are mentioned. G.R.S.

Electrochemistry applied to glass. ALEXANDER SILVERMAN. *Amer. Glass Rev.*, **50** [32], 13–14 (1931).—Studies on the following subjects are reviewed with reference to research and applications: (1) electrical conductivity of glasses at high temperatures including various silicates, aluminates, and mixtures of these by F. F. S. Bryson, (2) electrical precipitation of suspended solids in producer gas in the Osram Lamps Works in

Berlin and in a number of other factories in Europe, (3) chromium plating of molds, and (4) electroplating on glass. E.P.R.

Contribution to microchemical analysis of glasses. W. GEILMANN. *Glastech. Ber.*, **8** [7], 404–408 (1930).—The detection of zinc in glasses is taken up. The method of determining it as the well-crystallized zinc mercuric thiocyanate corresponding to the formula $Zn(Hg(CNS)_4)\cdot H_2O$, which forms crystals belonging to the rhombic system, is discussed. Copper, cadmium, and cobalt also can be detected as mercuric thiocyanates as they form mixed crystals of definite and typical colors. The applications of these methods are discussed, as is the increase in the sensitiveness and detection of traces of zinc. For previous work of this type see *Ceram. Abs.*, **9** [5], 386 (1930). Illustrated with photomicrographs. E.J.V.

Effect of size of opacifying particles on the form of light dispersion curves of opaque glasses. H. SCHÖNBORN. *Glastech. Ber.*, **8** [5], 280–83 (1930).—As in opaque solutions, so also in technical opaque glasses the size of the opacifying particles determines the relation between the actual and total transmissivity. With equal total transmissivity, the absolute magnitude and the wave-length dependent of the actual permeability are greater, the smaller the particles. The forms of the dispersion curves found for opaque glasses are also determined by the particle size. E.J.V.

Investigation on the colloidal nature of cadmium-sulphide glasses. G. A. SUCKSTORFF. *Glastech. Ber.*, **8** [5], 270–75 (1930).—The absorption spectra and the Tyndall cone of three technical cadmium sulphide glasses were investigated as to their dependence on the concentration of the coloring medium and annealing temperature. It was shown that the Tyndall cone is indefinite with fluorescent light. Only at high annealing temperatures does a pure Tyndall cone appear. Cadmium sulphide glass is also normally not a "colloidally colored glass." The form of the absorptions spectrum proved to be dependent on different causes. There probably occurs a decomposition of the cadmium sulphide at high annealing temperatures which is the principal cause of a slowly (not clean cut) shifting boundary in the short-wave spectrum regions. Illustrated. E.J.V.

Quantitative determination of the degree of oxidation of iron and manganese in glasses. FRANZ SALAQUARDA. *Glastech. Ber.*, **8** [5], 265–70 (1930).—The oxidation states in glasses of iron and manganese in different concentrations are discussed. Methods of quantitatively determining the separate degrees of oxidation of the two metals are given. With pure iron glasses there is always the same equilibrium between FeO and Fe_2O_3, even though melted with saltpeter additions. The independence of the color and the Fe_2O_3 content of these glasses are discussed. In pure manganese glasses there is an equilibrium between the two states of oxidation whereby the proportion of the higher valence manganese is approximately proportionate to the amount of the metal introduced. The formation of the higher valence manganese is found to be dependent on the oxidizing melting conditions and independent of the valence of the manganese introduced. In the glasses containing iron and manganese there is set up an equilibrium of the FeO to Fe_2O_3 as in the pure iron glasses, although the manganese dioxide introduced has released its oxygen during the melting and remains in the glass as manganous oxide. E.J.V.

Experiments on the cascade method of melting glasses. T. C. MOORSHEAD AND E. A. COAD-PRYOR. *Glastech. Ber.*, **8** [9], 513–19 (1930); for abstract see *Ceram. Abs.*, **10** [5], 335 (1931). E.J.V.

X-ray investigations of liquids and glasses. C. GOTTFRIED. *Glastech. Ber.*, **8** [7], 401–404 (1930).—The particle arrangements in the crystalline, liquid, and gaseous states are described. The origin and explanation of X-ray interference by liquids is briefly taken up. The effect of the molecular form on the number and structure of the rings

that appear is specially mentioned. A synopsis of X-ray investigations of glasses is presented. Illustrated. E.J.V.

Commercial glass transmitting ultra-violet light. PAUL DAVIDOVITCH. *Jour. Opt. Soc. Amer.*, **20**, 627–41 (1930).—After a review of work dealing with ultra-violet transmitting powers of certain glasses as related to their chemical compositions and the results of aging, D. concludes that (1) the raw materials should be pure and of the best quality, (2) the amount of iron and titanium in the raw materials should be as low as possible, (3) the melting should be done so as to change peroxides into oxides, (4) furnace and melting devices should not introduce iron and titanium into the melt, (5) the amount of oxygen in the furnace flame should be kept constant, (6) the phosphate glasses are unsuitable (although transparent to ultra-violet) for commercial purposes because of their high price and poor weather resistance, (7) commercial ultra-violet glass is best manufactured by using an ordinary soda-lime composition but removing all possible iron and titanium oxides and changing the remainder of these to the bivalent forms, (8) modern commercial ultra-violet glass transmits 30 to 80% in the 2800 to 3100 Å. region, (9) commercial ultra-violet glass is susceptible to aging, (10) the transparency of glass exposed to heat is reduced, and (11) there is some evidence that the usual coloration of ultra-violet glass changes from greenish before illumination to brownish after illumination. H.I.

Correlation of shade numbers and densities of eye-protective glasses. W. W. COBLENTZ AND R. STAIR. *Jour. Opt. Soc. Amer.*, **20**, 624–26 (1930).—Shade numbers of eye-protective glasses have been reduced to a standard formula of densities and corresponding per cent transmissions such that density, $D = {}^3/_7$ (shade number -1) = log (1/transmission) with maximum and minimum tolerances of D = $\pm$ 0.214. A table is given showing standard value of density with minimum and maximum tolerances for each shade number. H.I.

Fused quartz for 200-inch mirror. JOHN W. HAMMOND. *Ceram. Ind.*, **16** [5], 460–63; 492–95 (1931).—H. describes in detail the preliminary experiments and methods tried in producing a 66-inch disk of fused quartz, preparatory to the production of a 200-inch disk. He compares the methods, in all phases, with those used by the Bur. of Stand. in making a 70-inch glass disk. The manufacture of such an article from fused quartz is apparently easier and quicker than if glass were used, the cooling time required being very much less. The spraying of powdered silica through a flame has solved the method of forming the disk. See also *Ceram. Abs.*, **10** [2], 112 (1931). W.W.M.

Effect of cooling gas on flat glass. GUSTAV KEPPELER. *Glastech. Ber.*, **8** [7], 398–401 (1930).—It is shown that mouth-blown flat glass (on account of the strong attack of the chemically-active furnace gases on the upper surfaces in the flattening) possesses greater stability than in that lying on the flattening stone. Similarly great effects are not normally present in Fourcault glass as the cooling gas shafts are too well sealed against furnace gases. K. can show that in Fourcault glasses a subsequent treatment with carbon dioxide and sulphur dioxide results in an improvement in the surface. In technical glasses the improvement of stability proceeds to a lesser extent on account of the leakiness of the cooling shafts. Coated glasses are more stable, with the same composition, than those on which the coating is not recognizable. In all cases the improvement of stability decreases with the speed of drawing. From these results it follows that in practice one can bring about an improvement in the stability by the regulated introduction of chemically-active gases to the surfaces of the glass sheet in the cooling shaft. These effects are also shown on other sheet glasses. K. proposes the designation "surface improvement" for this kind of stability improvement. E.J.V.

Manufacture of rolled plate. VIII. ERNST LUTZ. *Glass Ind.*, **12** [5], 103–107 (1931).—The uniformity of heating of the leer chamber and the manner of its cooling

have equal influence on the flatness and on the danger of breakage of the rough glass sheet. The cooling curve that should be followed is schematically indicated in a graph and discussed in detail. The layouts and mechanical features of the leers used in Germany are discussed in detail. The standard practice followed is outlined. Illustrated. For Part VII see *Ceram. Abs.*, **10** [6], 418 (1931). E.J.V.

Natural gas in modern container factory. E. H. ADLER. *Ind. Gas*, 3 (1931); *Amer. Glass Rev.*, **50** [28], 13–16 (1931).—The Illinois-Pacific Coast Co. bottle plants in Los Angeles and San Francisco are described. Sand is dried in a rotary drier with gas fuel. Temperatures are maintained in a tank fired with gas to within 10° of the desired point. E.P.R.

Rapid development of glass machinery presents unusual problems. ANON. *Nat. Glass Budget*, **47** [1], 3 (1931).—In the past 20 years the development of machinery for glass production has been rapid. The manufacture of glass machinery presents unusual problems. Many parts are exposed directly to the high temperature of molten glass and other parts are alternately exposed to molten glass and then cooled by water or air blast. The modern glass machine should use nearly all the newly developed materials. Glass molds are made of carefully selected fine grain iron and knockout arms are of aluminum. Monel metal, Nichrom, tungsten-carbide materials, Ascoloy, Elkonite, Nitralloy, and other special metals having many different physical properties have some use in glass machinery for which they are especially well suited. In addition, there are more common materials such as paper, rubber, leather, resinous products, wood, nonferrous metals, etc. E.P.R.

Currents and temperatures in glass tanks. G. GEHLHOFF. *Glastech. Ber.*, **9** [1], 22–29 (1930); *Diamant*, **52** [16], 258–59 (1930).—The concept of currents in a throat tank was partly drawn up by direct observation of a floating body and partly ascertained on the basis of temperature measurements in the glass. The relations between temperature distribution in the tank and the current concept were determined. On the basis of consideration of the path of a glass particle from the batch pile to the drawing-off end through several different standards and on the basis of works results, it was determined that the undesirable cross-currents can be utilized for finding if the maximum temperature of the melting tank is maintained in the neighborhood of the opening. Illustrated. E.J.V.

Modern glass tanks. F. ECKERT. *Glastech. Ber.*, **8** [4], 193–206 (1930); *Diamant*, **52** [1], 3 (1930).—The developments of pot and tank melting of glass are compared. Modern tank practice and construction is described and discussed under the following heads: (1) iron coloration of tank glasses, (2) currents in the glasses in tanks, (3) checking and regulating influences on the currents, (4) continuous tank, (5) other low hearth forms, (6) economic factors, (7) regenerative and recuperative heating, (8) examples of performance, (9) batch composition and addition, and (10) size and performance comparison. Illustrated. E.J.V.

New flexible heating unit for leers. ANON. *Amer. Glass Rev.*, **50** [29], 12 (1931).—The General Electric Co. announces a new electric heating unit for glass-annealing leers of nickel chromium alloy ribbon. E.P.R.

Artificial air cooling for glassmelting furnaces. G. KÖRRN. *Keram. Rund.*, **38**, 238–39 (1930).—A review of established methods of ventilating furnaces and working places in glass factories is presented. H.I.

Continuous machines in the American wire-glass and flat-glass industries. F. STANG. *Keram. Rund.*, **38**, 434–36 (1930). H.I.

Automatic mechanism for the glass container industry. ANON. *Nat. Glass Budget*, **47** [1], 3 (1931).—Leers of the Amsler-Morton Co. are equipped with an automatic stacker which saves labor amounting to $12 per day and eliminates breakage losses

from 2½ to 3%. This saving added to the first item approximates $40,000 per year on a 6-leer installation. E.P.R.

Development of mechanical production of white hollow glassware. A. WENDLER. *Jour. Soc. Glass Tech.*, **14** [56], 353–68 (1930); *Glastech. Ber.*, **8** [8], 453–62 (1930); *Diamant*, **52** [17], 274–76 (1930); for abstract see *Ceram. Abs.*, **9** [10], 833 (1930). G.R.S.

Efficient annealing of glassware. ANON. *Nat. Glass Budget*, **46** [52], 3 (1931).—To make glass adaptable for commercial use it is necessary to remove any formation period (mechanical) strains or stresses set up in the glass article and to prevent thermal strains from forming while the slow-cooling process to atmospheric temperature is being accomplished. Articles formerly annealed in kilns requiring 60 to 110 hours are being and have been commercially annealed at a fraction of the time necessary in the kilns. Simplex leers are designed to use gas, oil, or electricity as the heating medium. E.P.R.

Lynch machine. J. M. HAMMER. *Amer. Glass Rev.*, **50** [30], 13–15 (1931); *Glass Ind.*, **12** [5], 113 (1931).—The new Lynch Model 10 machine is completely automatic, is of the pneumatic type, and has an automatic feeder and 2 tables carrying 6 molds each. E.P.R.

The Bethelehr. BETHEL ENGINEERING CO. *Glass Ind.*, **12** [5], 115–16 (1931).—In this leer the cooling is done by radiation alone, the ordinary mechanical methods for controlling the temperature not being used. Carefully designed and properly applied insulation controls the annealing zone. The muffled heat is applied in the top above the ware, eliminating any possibility of overheated belts. Illustrated. E.J.V.

History of Crystal City glassworks. R. A. MILLER. *Glass Ind.*, **12** [5], 99–102*A* (1931).—A brief historical account of Works No. 9, Pittsburgh Plate Glass Co., at Crystal City, Mo., is presented, tracing its development from its opening in 1872 to the present day. Illustrated. E.J.V.

Glass insulators at the Second World Crafts Conference, Berlin, 1930. F. NIEHAMMER. *Glastech. Ber.*, **8** [6], 367 (1930). E.J.V.

Weathering special window glass. ANON. Bur. Stand., *Tech. News Bull.*, No. 160, p. 80 (Aug., 1930); R.P., 113; *Ceram. Ind.*, **15** [3], 295 (1930); *Glass Ind.*, **11** [9], 205 (1930).—Attention is called to the fact that the special window glasses used to transmit ultra-violet radiation undergo a greater decrease in transmission when exposed to the mercury arc than when exposed to the sun and that further exposure of these glasses to the sun after exposure to the mercury lamp increases the ultra-violet transmission to a higher value than the minimum attained by the prolonged exposure only to the sun. Recent investigation and measurements made on these glasses showed that this overshooting amounting from 1 to 6% is not permanent but increases to a maximum after which it decreases again approximately to a value that is attained when only exposed to the sun. The decrease caused by ultra-violet radiation can be counteracted by maintaining the glass at a suitably high temperature. R.A.H.

Increasing window-glass market. ANON. *Ceram. Ind.*, **16** [5], 437 (1931).—The use of double glass windows with an air space between would increase the market for window glass and help to insulate buildings, since about 20% of heat is lost through walls compared with 80% through single glass windows. Fuel savings of 25% are estimated. W.W.M.

Quinquennial review of the mineral production of India for the years 1924 to 1928. Glassmaking materials. G. V. HOBSON. *Rec. Geol. Surv. India*, **64**, 392–99 (1930).—Chemical analyses of Indian glass sands are given (SiO_2 96.00, 98.95, 99.39, 98.10, and 99.80). (*C.A.*)

Glass process equipment. A. E. MARSHALL. *Chem. Met. Eng.*, **38** [4], 227 (1931).—Pyrex glass piping for chemical industries has been made possible through

the development of a new joint. The first all-glass column still was made in 1930 by Corning Glass Works. The advantages are visibility of reaction, its corrosion resistance, and its long continued efficiency. Glass tubular heat exchangers are another variant of the use of Pyrex piping. G.R.S.

Glass brick. ANON. *Ceram. Ind.*, **16** [5], 442 (1931).—The Corning Glass Works has started the manufacture of Pyrex glass brick in natural glass and several other colors. The brick have designs on the faces. Two designs are used, one a wavy effect and the other closely dotted. The brick are sold exclusively by the Architects' Brick Corp., New York. W.W.M.

Fused amber tint on headlights. ANON. *Ceram. Ind.*, **16** [5], 488 (1931).—The Overglaze Specialty Co., Los Angeles, Calif., has patented the idea of fusing an amber-tinted, transparent overglaze on automobile headlight lenses. The fog-piercing property of the light is increased from about 25 to 90 feet. W.W.M.

Glass or metal? ANON. *Elec. Rev.*, **108** [2786], 663 (1931).—A brief history of the use of glass and metal in lighting fixtures is given showing the increase in use of glass and metal with the development of lighting mediums from the use of oil through the modern use of electricity. E.P.R.

Expression of values of daylight illumination. C. C. PATTERSON. *Engineering*, **129**, 550 (1930). A.A.

Mirrors and reflectors. ANON. *Metal Prog.*, **19** [5], 92–96 (1931).—A brief history of the development of mirrors from the ancient use of wet slate to the modern telescope reflector is given. Silvered glass was not used until 1500. In 1860 several processes were used for precipitating a metallic silver coating on glass. Today tartaric acid and Rochelle salt processes are used almost exclusively. Silver nitrate is dissolved in ammonia and combined with the reducing or tartaric acid solution. A layer of solution $^1/_8$ to $^1/_4$ in. thick is poured on the surface of the glass. Precipitation of the metal starts immediately and continues for a half hour. The excess solution is then drained off. E.P.R.

Glass in modern home. ANON. *Amer. Glass Rev.*, **50** [32], 27–28 (1931).—The "Aluminaire" house is three stories high, has no cellar, is cubical in shape, and a portion of the ground floor is cut away to form an entrance, the overhanging second floor being supported by nickel-plated columns. Panels of curved glass at the side of the door are of tapestry glass which admits light yet permits privacy. The windows in the living room are made of "Lustraglass," which transmits a substantial amount of the shorter ultra-violet rays of sunlight and is the whitest glass made for windows. The space under the sills is filled with a heavy wire reinforced glass known as "Magnalite" glass which is effective as an obscuring medium, yet admits a maximum of light. The walls of the bedrooms and the library are of ultra-violet glass and the library and shower room are equipped with sky-lights of "Protex" glass containing horizontal reinforcements of wire. E.P.R.

Largest beacon light. ANON. *Nat. Glass Budget*, **46** [50], 14 (1931).—Located on the Merchants Bank Bldg., Indianapolis, is a red neon light sending a 2,000,000 candle-power flash that can be seen at a distance of 75 miles. One on the Lincoln Tower at Ft. Wayne is visible 50 miles away. E.P.R.

Glass marble made at Clarksburg factory. ANON. *Amer. Glass Rev.*, **50** [28], 23 (1931).—A new marble, "Master Sunburst," is similar to German handmade marbles, with colors streaked and blended into a transcript effect. All different colors are represented in some of the pellets and others are almost crystal clear. All are made automatically. E.P.R.

Ornamental glass. CLAIRE DARE. *Glass Ind.*, **12** [5], 102*B* (1931).—D. suggests that glassware manufacturers produce ornamental pieces for the home in the form of

glass drapery rods, glass figures, door-stops, silhouettes, and glass plaques in relief. Illustrated. E.J.V.

Glass universal. WILLIAM PICKETT HELM. *World's Work*, **40** [5], 57–64 (1931); *Amer. Glass Rev.*, **50** [30], 12 (1931).—A nontechnical description of the manufacture of glass products of various kinds is presented. Illustrated. E.J.V.

Georg Gehlhoff, noted German glass technologist. ALEXANDER SILVERMAN. *Amer. Glass Rev.*, **50** [31], 16 (1931).—Additional facts in the life of Georg Gehlhoff, noted German glass technologist, who died recently at Siders, Switzerland, are given. E.P.R.

BULLETIN

Study temperatures on and through glass. ANON. Univ. of Ill., Eng. Expt. Sta., *Bull.*, No. 223 (1931); *Nat. Glass Budget*, **46** [50], 19 (1931).—This bulletin contains two articles, (1) No. 9, "Storm Door and Sash," reporting the effect of storm sash on room temperatures, and (2) No. 11, "Surface Temperatures and Temperature Gradients through Walls and Glass." These are a continuation and an extension to previous investigations, the results of which were published in *Bulletins*, Nos. 169 and 192 (see *Ceram. Abs.*, **10** [4], 310 (1931)). E.P.R.

PATENTS

Leer. GEORGE W. BATCHELL AND FRANZ G. SCHWALBE. U. S. 1,800,203, April 14, 1931. In a leer, the leer formed of two sections, one of the sections angularly movable with reference to the other of the sections, a conveyer extending substantially throughout the length of the leer for conveying articles through the leer, a bracket secured to the outer end of the movable section, a second conveyer supported on the bracket substantially in the plane of the first-named conveyer for delivering articles to the first-named conveyer, means for moving the articles from the second-named conveyer to the first-named conveyer, and means for adjusting the movable section and the bracket according to the height of the articles conveyed to the leer while maintaining the portion of the conveyer within the movable section and the second-named conveyer movable over the bracket in the same plane.

Polishing and grinding machine. EDWARD M. MORRIS. U. S. 1,800,743, April 14, 1931. An abrading machine comprising a holder for the work, a movable spindle carrying an abrading tool, a member fixedly secured to the spindle, a pulley connected by yieldable means to the member whereby the frictional contact between the work and the tool will cause a relative movement between the pulley and the member, means for applying an abradant to the work and means actuated by the movement for controlling the abradant supplying means.

Flow control for glass tanks. ARNO SHUMAN. U. S. 1,800,909, April 14, 1931. A glass tank having in one wall thereof an outlet passage below the normal level of the molten glass therein, guide members on the tank adjacent the outlet passage, a gate structure slidable in the guides, a block of refractory material mounted in the gate structure on the side nearest the molten glass and having a sharp ridge forming the top edge thereof, a shaft adjacent the gate structure, crank arms on the shaft, links connecting the crank arms to the gate structure, and a lever connected to the shaft for operating the gate structure.

Sheet glass manufacture. CHARLES H. HARDING. U. S. 1,801,079, April 14, 1931. In combination with apparatus for developing sheet glass, a receptacle containing a mass of molten glass from which to draw a sheet, and means for effecting angular movement of the receptacle while a sheet is being drawn.

Gage for sheet glass. WILLIAM GRAY AND WILLIAM BROWN. U. S. 1,801,270, April 21, 1931. In a thickness-indicating gage for sheet material, a pair of rollers adapted to engage the opposite sides of the sheet and being movable relative to one

another, a frame carrying the rollers, means for supporting the frame so that it may swing bodily at right angles to a sheet disposed in a predetermined position to allow the rollers to follow a warped sheet, and means on the frame for indicating the distance between the rollers.

Display vase. ROBERT E. MCELDOWNEY. U. S. 1,801,281, April 21, 1931. The herein described display vase, comprising duplicate upper and lower members provided with shoulders and having juxtaposed abutting portions exteriorly threaded and adapted to be in contact when assembled, and a continuous, integral, threaded coupling member having its upper and lower terminals in contact with the shoulders, the distance between the shoulders being substantially the same as the length of the coupling member.

Sheet-glass drawing apparatus. JAMES T. ZELLERS. U. S. 1,801,298, April 21, 1931. In apparatus for producing sheet glass, a glassmelting furnace adapted to contain a constantly moving body of molten glass, a working receptacle in communication with the furnace for receiving the molten glass therefrom, means immersed within the molten glass within the furnace at substantially the juncture thereof with the receptacle for diverting the flow of surface glass from the center of the furnace and causing it to enter the receptacle at the sides thereof only, and a removable floater member associated with the means.

Glass-handling apparatus. JOHN L. DRAKE. U. S. 1,801,305, April 21, 1931. Sheet-handling apparatus comprising in combination, a pair of spaced suction members for engaging a sheet, a supporting frame therefor, means for vertically slidably mounting the members for movement differential distances, and means connecting the suction members to a suction device.

Transferring molten glass from tanks into pots. JOHN L. DRAKE. U. S. 1,801,306, April 21, 1931. The method of passing molten glass from a tank having an outwardly projecting overflow spout into a pot, which consists in telescoping the pot and spout in a substantially horizontal plane, moving the pot relative to the spout into a substantially vertical position, in simultaneously flowing the molten glass from the tank into the pot, and in preventing the flow of glass from the pot during movement thereof.

Glass-handling apparatus. JOHN C. GIPE. U. S. 1,801,309, April 21, 1931. In apparatus of the character described, the combination with a series of cars movable in a horizontal direction and upon which glass sheets are adapted to be supported, of a carriage movable parallel with the cars, and suction means pivotally mounted upon the carriage and adapted to swing to a substantially horizontal position either over the cars or to a substantially horizontal position over the carriage, the sheet glass carried thereby being turned over during such movement.

Sheet-glass surfacing apparatus. JOHN E. LANDOLT. U. S. 1,801,314, April 21, 1931. In sheet-glass surfacing apparatus, means for supplying polishing medium to the sheet of glass to be surfaced, the means comprising a main conduit containing a polishing medium, an inclined header, means connecting the main conduit and header, a valve in the connecting means for controlling the supply of polishing medium to the sheet of glass to be surfaced, a plurality of pipes connected to the header and inclining upwardly away therefrom, and a valve-controlled drain pipe connected to the lower end of the header adapted to drain the plurality of pipes and the inclined header when the valve in the main conduit and header connecting means is closed.

Gathering molten glass. JOHN F. RULE AND LEONARD D. SOUBIER. U. S. 1,801,-457, April 21, 1931. In a glass-forming machine, the combination of a mold for gathering glass by suction and an implement attached to the mold in position to project downwardly below the bottom of the mold behind the mold cavity.

Rolling glass sheets. LEANDER N. POND. U. S. 1,801,689, April 21, 1931. The hereinbefore described process of forming sheet glass at a forming pass which comprises

the arresting of the rotation of a roll forming one wall of the pass, and while arrested unequally cooling the roll to give an initial warp to the roll, putting the roll in rotation and feeding glass to the pass at such time that it will contact first with the cooler portion of the roll.

Utilizing solar heat. CHARLES GREELEY ABBOT. U. S. 1,801,710, April 21, 1931. In a device for utilizing the heat of the sun's rays, the combination of a boiler having its upper and lower surfaces formed by plates spaced a short distance apart and inclined to the horizontal, means for introducing fluid along the bottom edge of the boiler, a steam chest along the top edge of the boiler, insulation for the sides and bottom of the boiler, and a tight screen transparent to the sun's rays and covering the top of the boiler consisting of a series of evacuated glass tubes.

Glass-rolling machine. RICHARD GENENGER. U. S. 1,801,733, April 21, 1931. In a machine for rolling plate glass, a pair of coöperative forming rolls, an inclined chute for receiving the plates emerging from between the forming rolls, and a rotatable vertical roller located at each side of the chute for smoothing the edges of the glass plate while passing over the chute.

Glass-shaping machine. THOMAS COURTNEY MOORSHEAD. U. S. 1,802,031, April 21, 1931. In a glass-shaping machine, the combination of a mold open at its upper end, a vertically movable pressing plunger of predetermined weight, means for raising and lowering the pressing plunger, means whereby, during the latter part of its downward stroke, the pressing plunger is caused to press on the glass in the mold under the influence of its own weight alone so that the plunger can exert the same pressure on the glass during successive operations, irrespective of the distance of travel of the plunger, and a support on the plunger for receiving weights.

Glass feeder. ALBERT R. BETHEL. U. S. 1,802,072, April 21, 1931. (1) The method of controlling the feed of glass of different temperatures flowing from a source of supply for discharge through an outlet under control of a periodically operated control device, which consists in causing the control device to retard the rate of flow of the hotter glass with respect to that of the cooler glass. (2) In a glass feeder, a receptacle having a glass-storage chamber, an outlet, and a well leading from the storage chamber to the outlet, a reciprocatory plunger controlling the flow of glass through the well and to the outlet, and means pivotally supporting the plunger for universal swinging movement in the well laterally of its normal line of reciprocatory movement.

Sheet-glass apparatus. ALBERT E. EVANS. U. S. 1,802,142, April 21, 1931. The combination with a pair of rolls for forming sheets of glass successively in ribbon form from bodies of molten glass, a vertically movable runway extending forwardly from the rolls and provided with means for carrying the glass ribbons therealong, and a plurality of roller-leer sections or units in advance of the runway, one above the other, and means for operating the rolls of the runway and those at the entrance of the leer at a relatively higher speed than the rolls following the entrance rolls and extending through the body of the leer, the runway being mounted so that its outlet end may be brought into alignment with any one of the leer sections or units.

Manufacture of composite glass. HERBERT JOHN MALLABAR. U. S. 1,802,213, April 21, 1931. Method of forming composite sheets of glass and cellulose acetate which consists in pretreating glass sheets by coating them with a thin layer of hardened but still soluble gelatin, coating the sheets so treated with a further layer of soluble gelatin, pretreating a sheet of cellulose acetate with ether, coating the sheet with soluble gelatin, placing the coated sheet of cellulose acetate between the sheets of glass and uniting them by pressure in presence of a volatile softening liquid for gelatin.

Manufacturing glass bottles with patterns. KINSUKE KISHIDA. U. S. 1,802,431, April 28, 1931. The herein-described process of applying a patterned film to the inner

side of the wall of a bottle, consisting in placing such film in a bottle, filling the bottle with a substantially liquid adhesive to such an extent as to cause the adhesive to coat the opposing surfaces of the bottle wall and film and by its pressure to apply the adhesive to the bottle wall and finally discharging the adhesive from the bottle, leaving the film in place.

Automatic temperature control for glass. LEONARD D. SOUBIER. U. S. 1,802,789, April 28, 1931. In combination, a container for molten glass, means for supplying molten glass thereto, the container having a discharge outlet to which the glass flows continuously from the point at which it is supplied to the container, a heating device arranged to apply heat to the flowing glass in the container, a valve adapted to control the flow of fuel to the heating device, and automatic valve actuating means, including a thermocouple located in proximity to the surface of the glass in the container at a point remote from the discharge outlet but intermediate the outlet and the point at which the heat is applied to the glass.

Glassware buck. GEORGE E. ROWE. U. S. 1,802,928, April 28, 1931. In a glassware buck, the combination of a traction element, ware-supporting paddles connected to the traction element, means for varying the angle of inclination of the traction element to the horizontal, and means effective for a plurality of varying angles of inclination of the traction element for maintaining the paddles in a horizontal position during their load-bearing travel.

Blowing hollow glassware. ROBERT W. CANFIELD. U. S. 1,803,001, April 28, 1931. (1) The method of blowing hollow glassware which comprises delivering a volume of air to a parison at a relatively rapid rate of flow to expand the parison quickly into a bulbous configuration approximating that of the mold and thereafter delivering a volume of air to the parison at a reduced rate of flow to expand the parison into contact with the walls of the mold. (2) The combination with a glass-shaping mold and coöperating blowhead, of a source of air under relatively high pressure, a pressure-accumulating chamber, means including a relatively restricted continuously open passage for establishing communication between the source and the system including the blowhead and the chamber, a valve for interrupting communication between the blowhead and both the source and the chamber, and means for opening the valve to permit the air in the chamber to flow unrestrictedly to the blowhead at a relatively rapid rate to impart a predetermined preliminary configuration to a parison in the mold and subsequently to permit air from the source to flow to the blowhead at a decreased rate to blow the parison to final form.

Annealing glassware. VERGIL MULHOLLAND. U. S. 1,803,031, April 28, 1931. Apparatus for annealing glassware, comprising a tunnel, means for transporting articles of glassware through the tunnel, a flue associated with the tunnel, means for causing a temperature-controlling medium to flow through the flue, a hood disposed above the exit end of the tunnel and communicating with the interior thereof, means for establishing communication between the flue and the hood, a series of baffle elements disposed in the hood, and means for causing a portion of the temperature-controlling medium to flow from the flue into the hood and thence into the tunnel, to provide a gaseous curtain adjacent to the discharge end thereof.

Windshield for leers. CLAUDE NAGLE. U. S. 1,803,032, April 28, 1931. The combination with a tunnel leer having an opening at the receiving end thereof, of a radiation shield adjacent to the opening and outside the tunnel, the shield having an air passage extending therethrough, means for supplying air to the inlet end of such passage, the passage having an orifice at its outlet end for discharging the air away from the opening, and means for adjustably varying the vertical distance between the orifice and the floor of the tunnel when annealing glass articles of varying heights.

Glass-grinding machine. HENRY FORD. U. S. 1,803,752, May 5, 1931. In a glass-grinding machine, means for conveying a sheet of glass on edge between opposed grinding disks to thereby grind both faces of the sheet simultaneously, and means for submerging the sheet in a cooling liquid during the grinding operation.

Making glass wool sheets. PAUL O. E. FRIEDRICH. U. S. 1,804,254, May 5, 1931. The method of making a matted sheet of vitreous material comprising heating the vitreous filaments to reduce the cohesion thereof, feeding the filaments onto a moving surface having a direction of movement transverse with respect to the filaments whereby the filaments will individually adhere to the moving surface and be pulled out from bundled relation to arrange themselves in haphazard, interlaced fashion upon the surface, impregnating the mass of interlaced filaments with a binder to effect permanent union, applying pressure to the mass to compress it to the desired thickness and density and drying the same.

Glass-edging machine. COLLIS S. MAYFLOWER. U. S. 1,804,263, May 5, 1931. In a glass-edging machine including a bed plate, a grinding element rotatably mounted upon the plate, and an edging table disposed transversely above the grinding element, means for adjustably supporting the table above the grinding element comprising a pair of vertically adjustable uprights supporting one end of the table upon the bed plate and each having a hinged joint the axes of which align transversely of the table, and a vertically adjustable support for the opposite end of the table comprising an adjusting screw rotatably connected at its upper end to the under side of the edging table at the longitudinal center thereof and having a screw-threaded lower end, and a block rigidly carried by the bed plate and having a vertically extending threaded bore for receiving the lower threaded end of the adjusting screw.

Manufacture of reinforced glass. WALTER J. BLENKO. U. S. 1,804,395, May 12, 1931. Apparatus for making reinforced glass comprising a bath of molten glass, a guide extending upwardly through the bath and adapted for the feeding of a reinforcing material therethrough, the guide terminating below the surface of the glass whereby as the reinforcement rises upwardly glass adheres thereto and forms a meniscus, means for drawing the formed glass upwardly, shaping dies having initial sliding contact with the meniscus, and means for cooling the dies.

Sheet-glass apparatus. JOSEPH P. CROWLEY. U. S. 1,805,206, May 12, 1931. Means for pressing a moving sheet of glass to a substantially flat uniform thickness, including a substantially horizontal movable conveyer for supporting the sheet, a pressing member mounted above the sheet, a horizontal supporting member for the pressing member, arms carried by the pressing member and having rollers movably supported by the supporting member, and means for moving the pressing member horizontally with respect to the supporting member when the pressing member is in engagement with the sheet.

Temperature-control means for molten glass. LEOPOLD MAMBOURG. U. S. 1,805,218, May 12, 1931. In apparatus for producing sheet glass, a drawing chamber containing a mass of molten glass from which the sheet is adapted to be drawn, a plurality of heat-conducting flues submerged within the mass of molten glass and extending transversely of the chamber at spaced locations longitudinally thereof, intake and exhaust manifolds arranged at opposite sides of the drawing chamber and with which the opposite ends of the flues communicate, means for creating a continuous circulation of gaseous fluid through the manifolds and flues, means associated with the intake manifold for heating the gaseous fluid prior to its passage through the flues, and a damper associated with the intake end of each flue for controlling the amount of heated gaseous fluid passing therethrough to the outlet manifold.

Sheet-molding apparatus. JOHN L. DRAKE. U. S. 1,805,237, May 12, 1931.

In sheet-glass apparatus, a mold comprising a pair of approximately vertical mold plates pivotally associated with one another and normally positioned in upwardly diverging relation to create a mold cavity therebetween for receiving therein a quantity of molten glass, and means for moving the plates toward one another to reduce the molten glass therebetween to sheet form, including a link mechanism associated with each plate, and separate operating means for each link mechanism.

Sheet-width maintaining device. LEOPOLD MAMBOURG. U. S. 1,805,250, May 12, 1931. In sheet-glass apparatus, a slab, means for flowing glass thereon, and means contacting with the edges of the flow while on the slab and moving therewith to prevent narrowing thereof.

Laminated glass. JAMES W. H. RANDALL. U. S. 1,805,259, May 12, 1931. The process of producing laminated glass consisting in arranging a sheet of nonbrittle material on a sheet of glass, mounting sealing material strips on the sheet of glass and around the nonbrittle sheet and in the same plane therewith, then placing a second sheet of glass thereover and combining the whole into a composite structure.

Sheet-glass apparatus. JOSEPH A. REECE. U. S. 1,805,260, May 12, 1931. In sheet-glass apparatus, a substantially vertically arranged slab composed of two adjacent sections having a vertical opening therebetween, each section having a trough in its upper end and the opposite ends of the troughs of the two sections communicating with one another, means for flowing glass into one of the troughs from where a portion of it will pass into the other trough, the glass flowing from the troughs downwardly over the slab to form a sheet, means for passing a wire mesh downwardly through the opening between the slab sections, and a pair of rolls for reducing the sheet to the desired thickness as it leaves the slab.

Glass-sheet drawing apparatus. PAUL ESCOLE. U. S. 1,805,329, May 12, 1931. In glass-sheet drawing apparatus including a pair of rollers and means for pressing the rollers against opposite faces of the sheet, a suspension device for the movable roller comprising a bearing bush for the trunnion of the roller, a bearing block through which pressure is exerted upon the trunnion, and a spherical seating of the bush within the bearing block.

Laminated glass products. WILLIAM C. BULL. U. S. 1,805,389, May 12, 1931. A glass-product fabricating machine including an oven, a press therein having opposite pliable pressure members, pressure and vacuum means acting against the members, and a single control for the pressure and vacuum means.

Strengthened glass, etc. J. CHAMBERLAIN AND H. PERIAM. Brit. 345,688, April 9, 1931.

Pouring contents from crucibles, etc., used for feeding machines for rolling glass. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, & CIREY. Brit. 346,601, April 22, 1931.

Tempering glass. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, & CIREY. Fr. 695,035, Aug. 7, 1929. An arrangement is described for blowing air onto the heated glass. Fr. 695,040, Aug. 8, 1929. An apparatus for tempering glass consists of 2 hollow plates through which cooling liquid flows and between which the sheets of glass are mounted. See also *Ceram. Abs.*, **10** [5], 346 (1931). *(C.A.)*

Structural Clay Products

Fundamentals and economies in the clay industries. IV. ELLIS LOVEJOY. *Clay-Worker*, **95** [4], 245–48 (1931).—In an endeavor to bring about better comprehension L. discusses its theories of plasticity, and shows how the origin of clay has an effect on this

property. Illustrations are cited to clarify points regarding plasticity of clays. Methods of treating clays prior to working them in order to reduce plasticity troubles are discussed. For Part III see *Ceram. Abs.*, **10** [6], 428 (1931). E.J.V.

Flatulence of ceramic products when heated. O. KALLAUNER. *Stavivo*, p. 679 (1930).—Flatulence is caused by the pressure of inclosed gases, *i.e.*, water vapor, air, oxygen, carbon dioxide, and sulphur dioxides. To reduce this the following points should be observed: (1) the raw material must be washed and suitably prepared, (2) excessive fatness should be avoided, (3) carbonaceous substances in the clay must be burned at about 500°C, (4) the firing should progress slowly, (5) contents of steam in the kiln space should be reduced to a minimum, (6) sufficient draft must be provided in the kiln, (7) firing at 800 to 900°C must be carried out in a reducing atmosphere in order to decompose sulphates, (8) access of air must be facilitated so that the carbonaceous substances may be burned. R.B.

Deterioration of ceramic goods by frost. JOSEF MATĚJKA. *Stavivo*, p. 447 (1930).—The resistance to frost is not directly dependent on density. Absorption is not a reliable criterion for resistance to frost. Brick impregnated by lime water are waterproof and have a higher resistance to frost. R.B.

Manufacture of light-weight units of clay and combustible admixtures. AUG. E. BUCH. *Ziegelwelt*, **62**, 31–32 (1931); for abstract see *Ceram. Abs.*, **9** [12], 1046 (1930). (*C.A.*)

Natural colors of fired clayware. ABDE ALLY. *Jour. Indian Ceram. Soc.*, **3** [1], 5–33 (1931).—A critical summary of the available literature on the influence of composition and the processes of manufacture on the natural fired colors of clays is given. (1) Under composition the effect of iron, its origin, subdivision, amount, different mineral forms, and its removal influencing the natural fired color are considered. Effects of manganese dioxide, titanium dioxide, vanadium, and of such accompanying minerals as lime, alumina, carbon, sulphur, and fluxes are also discussed. (2) Under methods of manufacture factors affecting the colors, the raw materials, their uniformity, foreign materials, storage and aging, grain size, and drying and firing are taken up. Dissociation of Fe_2O_3 in air and color phenomena during black coring, blue stoning, and overfiring are described under firing operation. The latter also includes effects of reducing gases, sulphur gases, and water vapor, the production of greens, browns, etc., by the manipulation of the kiln atmosphere, and blue smoking and the flashing phenomena. A bibliography of the literature is also given. A.A.

Developments in reinforced brickwork. ANON. *Brit. Clayworker*, **39** [467], 447–48 (1931).—A discussion is given of papers on reinforced brickwork presented at the recent meeting of the C.B.M.A. held in Philadelphia, Pa. Reference is also made with photographs to reinforced brickwork in Japan. R.A.H.

Develop method of reinforced brickwork. WALTER R. SIMONS. *Brick Clay Rec.*, **78** [9], 483–85 (1931).—Several methods of reinforcing brickwork by the use of short lengths of steel rod instead of long steel bars are described. Comments by Hugo Filippi are presented. Illustrated. E.J.V.

Properties of brickwork as compared with other building materials. O. KALLAUNER. *Stavivo*, p. 301 (1930).—Tables are given comparing results of tests made with brickwork, concrete and plaster walls, and brick. R.B.

Heat passage and warming through of brickwork. B. HELAN. *Stavivo*, p. 698 (1930).—The warming through of a wall (P) is inversely proportional to the thickness of the wall (b). $P = \frac{\lambda}{b}$, λ being the heat conductivity. Handmade brick are characterized by better heat-insulation capacity ($P = 0.39$) than mechanically-manufactured brick ($P = 0.48$) or mortar ($P = 0.58$). H. gives a survey of the relation existing be-

tween warming through and degree of moisture and other properties of the brick including the capacity of accumulating heat. In the case of perforated and hollow brick, the property of warming through and the capacity of accumulating heat is lessened. R.B.

Tests on large size brick and of brickwork erected therefrom. F. KLOKNER. *Stavivo*, p. 673 (1930).—The standard size Czechoslovakian brick is 29 x 14 x 6.5 cm., but now a small size 24 x 12 x 6.5 cm. is being introduced. Small brick show 5% higher mechanical resistance than larger brick and the strength of brickwork made therefrom is greater, permitting better utilization of the mechanical properties of the brick. R.B.

German masonry treatments. ANON. *Bldg. Econ.*, **7** [4], 4–6 (1931).—The outstanding feature of brickwork is elaboration of detail which almost approaches the grotesque. While the German taste runs to exaggerated effects obtained by the use of brick in odd designs and columned façades, the early Persian architects specialized in delicate lace-like patterns. Typical examples of German architecture are described and illustrated. E.P.R.

Czechoslovakian Ministry of Public Works proposed standards for fired brick. O. KALLAUNER. *Stavivo*, p. 224 (1930). R.B.

Comments on use of large-size brick units. E. A. VAN VLECK. *Brick Clay Rec.*, **78** [9], 481 (1931).—Favorable criticism of the use of over-sized brick is presented. Comments on this practice as observed in Holland and Sweden are given. E.J.V.

Standards for stoneware paving tile. O. KALLAUNER. *Stavivo*, p. 29 (1931).—The standardization committee of the Czechoslo. Ceram. Soc. finished extensive preparatory studies in view of elaborating standards for paving tile. The tile have the following proposed dimensions: 15 x 15 x 1.5 cm. There are, however, 13 other sizes admitted. The limits are as follows: 1st class goods ±1%, 2nd class goods ±2%, and thickness, ±10%. The study comprises 27 drawings of various molded stones. The standards are applicable to the following properties: appearance, dimensions, sound, structure of fracture, impregnation capacity, resistance to acids, and resistance to wear. R.B.

Standardization of drain pipes in Czechoslovakia. O. KALLAUNER. *Stavivo*, p. 2 (1930).—(1) Length: 33 cm., (2) gage: 5, 6.5, 8, 10, 13, and 20 cm., (3) criteria of quality: texture, sound, resistance to wear. R.B.

Hollow brick with closed ends. ANON. *Brit. Clayworker*, **39** [467], 449–51 (1931).—A description of the "Hexasystem" invented by an Austrian for making hollow brick with either one or both ends closed is given. The machine equipment for the process comprises 3 principal parts, (1) for cutting off the hollow brick, (2) automatic transfer of the cut-off brick to closing mechanism, and (3) closing operation itself. The closed-end block for fireproof flooring is also discussed. Illustrated. R.A.H.

"Avan" brick. O. KALLAUNER. *Stavivo*, p. 37 (1931).—In hollow brick (invented by L. Avanzini, 1920) the hollow spaces do not extend clear through. The apertures are produced by a special perforating press having a capacity of about 2000 brick per hr. R.B.

Hudson River colored brick. ANON. *Brick Clay Rec.*, **78** [8], 424 (1931).—Leaders among the Hudson River common brick manufacturers are giving more attention to shades and colors. Sales show a gain of 35% over 1930. E.J.V.

Du-Brik, one-unit wall. METROPOLITAN PAVING BRICK CO. *Brick Clay Rec.*, **78** [8], 444 (1931).—Du-Brik is a hard-fired clay product with the insulation and fireproof advantages of hollow tile and the appearance and beauty of face brick. It is simple in design, coming in two sizes $2^{5}/_{8}$ x 8 x 8 in. and $2^{1}/_{4}$ x 8 x 8 in., with three dead air spaces, $1^{3}/_{4}$ x 1 x $1^{3}/_{4}$ in., and 7 vertical holes $^{1}/_{2}$ in. in diameter running through both front and back shells. Illustrated. E.J.V.

Advantages of brick walls. DUŠAN JURKOVIČ. *Stavivo*, p. 686 (1930).—Some advantages are smaller weight of constructional units, higher strength and insulating

capacity, less quantity of water required for building, dryness of the walls, etc. R.B.

Interior walls of clay. I. ANON. *Brick Clay Rec.*, **78** [8], 436–40 (1931).—There is a market for clay products for exposed interior wall surfaces. A tabulation of the potential applications indicates an extensive field for development. Questions of products available and the practicability of interior walls of exposed clay products from the standpoint of cost are taken up. **II.** *Ibid.*, **78** [9], 478–81 (1931).—Some of the uses of clay products for interior walls in residential buildings are specifically described and illustrated. E.J.V.

Salt-glazing clayware. ANON. *Brick Clay Rec.*, **78** [9], 489–92 (1931).—The limits of composition of the clays that will permit salt glazing are defined. The questions of type of kiln, effect of kiln atmosphere, and effect of scummed ware on salt glazing are discussed in this description of the process. E.J.V.

Soft-mud brick machinery. ELIAS PETTS. *Brick Clay Rec.*, **78** [8], 442–44 (1931).—In this discussion of the early history of soft-mud brick machinery some of the first portable units and their operation in conjunction with soak pits are taken up. Methods of gathering and preparing the clay are described. Illustrated. E.J.V.

Back-travel in brick and tile machines. ANON. *Brit. Clayworker*, **39** [467], 452–53 (1931).—The clay should pass steadily forward in a brick- or tile-making machine, but in many instances a portion of the clay travels backward between the periphery of the blades and the barrel. If the blades are in the wrong position, too short, or placed at an unsuitable angle, the clay may work backward instead of forward. The blades having the greatest propelling power are those which form a complete screw thread about the shaft. In many pug mills the blades are deliberately placed so as to mix the clay and not propel it. Sometimes a clay works backward because it is imperfectly mixed or because the machine is fed irregularly. On no account should water be added to the contents of the brick machine, as there will be a strong tendency for backward movement of the clay. R.A.H.

Beauty in modern brick. ANON. *Brick Clay Rec.*, **78** [9], 492–93 (1931).—The great variety of style possible with a fired-clay unit is illustrated with photographs of some decorative designs worked out with brick. E.J.V.

Painting brick houses. ANON. *Bldg. Econ.*, **7** [4], 12–13 (1931).—Painting brick houses has no advantage other than architectural effect. E.P.R.

American Face Brick Assn. strikes at price fallacy. ANON. *Brick Clay Rec.*, **78** [8], 445–46 (1931).—Methods used to combat the fallacy that a face-brick house costs too much to build in comparison with a frame house are described. Illustrated. E.J.V.

Brick façade in architecture. A. DRYAK. *Stavivo*, p. 685 (1930).—In Bohemia many interesting buildings with brick façades dating from the 14th Century may be found. R.B.

Handmade brick. VÁCLAV ŠTEBGL. *Stavivo*, p. 141 (1930).—In Western Bohemia and Šumava (Böhmerwald) the brick are molded in a vertical position. In the other regions of Bohemia and Moravia the brick are molded in a flat position. R.B.

Brickmaking in Persia. ANON. *Bldg. Econ.*, **7** [4], 14 (1931).—Some of the masonry centuries old is as fine as any found in the Near East whose present manufacturing methods are most primitive. The brick are made by hand near the kiln and are sun dried. Some examples and a brief description are included. E.P.R.

Better quality at lower costs. H. F. GOSS. *Brick Clay Rec.*, **78** [8], 428–33 (1931).—A detailed description is given of modernizing the plant of the United Materials & Richmond Brick Co., Ltd., of San Francisco. The old plant was kept operating to

capacity while reconstruction work was under way. A variety of products are manufactured. Illustrated. E.J.V.

Brickworks laboratory. JOSEPH MATĚJKA. *Stavivo*, p. 689 (1930).—M. describes a modern factory laboratory for brickworks. R.B.

Brick patents. A. CHMELÍČEK. *Stavivo*, p. 112 (1930).—C. discusses the latest Czechoslovakian patents concerning brick, especially hollow brick with closed cavities. R.B.

Drainage tube joints. ANT. CHOOLÍČEK. *Stavivo*, p. 695 (1930).—C. is owner of a Czechoslovakian patent (No. 32,505) relating to the connection of drain tubes. His method consists in chamfering the tubes laterally and pressing one to another. This joint has proved advantageous. R.B.

BOOK

Plain and fancy brickwork. W. S. LOWNDES. David McKay Co., 1929. 62 pp. *Jour. West. Soc. Eng.*, **36** [2], 134 (1931).—The book is divided into two parts, common brickwork and face and ornamental brickwork. Manufacture, properties, uses, and methods of using common brick are discussed. Some brick constructions are given in detail. A short history of face brick is included with descriptions of the various kinds. W.W.M.

PATENTS

Making closed tile. ROY A. SHIPLEY. U. S. 1,800,324, April 14, 1931. (1) The combination with a die having openings for forming a hollow body and a strip of the same material as the body, and a receiving conveyer, of means for sectioning the body, means for turning the successive sections at an angle to their direction of movement along the conveyer, means for applying a strip section to an end of each body section, and means for subsequently conveying the assembled body and strip. (2) The combination with a die having openings for forming a hollow body and strips of the same material as the body, and a receiving conveyer, of means for sectioning the body, means for turning the successive sections at an angle to their direction of movement along the conveyer, means for applying the strip sections to the ends of each body section, and means for subsequently conveying the assembled body and strips. (3) The combination with means for forming hollow bodies and a strip of the same material, of means for moving successive bodies relatively to the strip, and means for applying a strip section to an end of each body.

Brick-handling machine. WILLIAM W. WALLACE. U. S. 1,800,971, April 14, 1931. In a brick-handling machine, a plurality of groups of fingers and means for tilting one group of fingers relative to the other.

Truck. ROBERT A. FONTAINE. U. S. 1,803,058, April 28, 1931. In a brick-handling device, a truck including a frame, supporting means carried thereby, an axle carried by the supporting means and equipped with ground engaging wheels, in combination with a body of casing-like formation adapted to be embracingly engaged upon a hack of brick, resting upon spaced supporting elements, foot members carried by the body and having toe pieces adapted to enter between the supporting elements for engagement beneath the hack, and means detachably and pivotally connecting the body with the truck frame, the foot members having ground engaging surfaces at an angle to the toe pieces.

Tile. HOWARD L. WHEELER. U. S. 1,803,158, April 28, 1931. A tile having horizontally and vertically extending walls and a void between the walls, one of the walls terminating in an overhanging ledge shaped to form a handle under which one's fingers may extend in lifting the tile, the handle extending from end to end of the tile.

Brickmaking machine. ROY P. M. DAVIS. U. S. 1,803,546, May 5, 1931. A

brickmaking machine having a mold-supporting means and a pallet-supporting means adapted to receive and slidably support the mold and pallet thereon, the mold-supporting means and the pallet-supporting means also adapted to maintain the bottom of the mold and the top of the pallet in the same substantially horizontal plane, a fixed thin smooth liner sheet adapted to rest beneath the mold and upon the pallet, and means for transferring the mold across the face of the liner sheet directly to the pallet without disturbing the substantially horizontal position of the mold.

Refractories

Electric-furnace production of high heat-duty refractories. F. W. SCHROEDER. *Ind. Eng. Chem.*, **23** [2], 124–26 (1931).—S. describes the process and materials used for the manufacture of Corhart refractories. The cast refractory has a P.C.E. of cone 37. There is a close temperature range from solid to liquid and it does not deform gradually under combined load and temperatures below its melting range. Its linear expansion is approximately one-half that of first-class fire brick. The finished blocks cannot be chipped, cut, worked, or shaped but may be ground on alundum wheels. Silicon carbide should not be used for grinding refractories for use in glass tanks because of the deleterious effect of small amounts of the material on the quality of the glass. Blocks as large as 18 x 48 in. weighing about 1625 lb. are cast satisfactorily. Although developed for use only in glass tanks these refractories have other uses, *e.g.*, lining the hot zone of rotary kilns, in the portion of boiler furnaces exposed to particularly severe duty, and in metallurgical equipment such as forging furnaces. Greater first cost is in many cases more than compensated for by longer life. R.G.M.

Refractory materials for electric furnaces. I. Melting of lead and its alloys. ALFRED B. SEARLE. *Metal Ind.* [London], **38**, 3–4 (1931).—The maximum temperature attained in an electric furnace when melting Pb or Pb alloys is about 1000° and generally much lower. Electric furnaces are the most suitable for melting this class of alloys. The properties of various refractory brick are outlined. Magnesia brick are suitable for parts of a Pb furnace in contact with slag. For most induction furnaces dead-burned magnesia is best with pitch or colloidal MgO as binding material. A melted mixture of PbO and clay applied as a paste affords protection to the refractories in high-frequency furnaces for these fusible alloys. Silica brick are used in the roofs. Most refractory materials are good conductors of electricity at red heat. This often results in serious leakage of current and may cause a serious defect in the furnace. (*C.A.*)

Metallurgical refractories. HYSLOP. *Iron & Coal Trades Rev.*, **3**, 429 (1931); *Refrac. Jour.*, **7** [4], 264 (1931).—H. deals with high-alumina fire brick, the action of fluxes on refractories, and the cost of production. Reference is made to the resistance of refractories (1) to temperature, (2) to solution, disintegration by fluxes, and dust laden gases, and (3) to rapid temperature changes. High-alumina brick are used more in non-ferrous than in iron and steel furnaces, but there is little doubt that in ferrous metallurgy they will eventually be widely used in positions where high resistance to temperature and corrosion are required. E.P.R.

Checker-brick investigation. R. M. KING AND GILBERT SOLER. *Blast Fur. Steel Plant*, **19** [5], 724–26 (1931); see also *Ceram. Abs.*, **10** [4], 275–76 (1931). E.J.V.

Dolomite refractories. F. HARTMANN. *Refrac. Jour.*, **7** [4], 264 (1931); for abstract see *Ceram. Abs.*, **9** [6], 437 (1930). E.P.R.

Magnesia refractories. F. REINHART. *Rock Prod.*, **34** [9], 98–99 (1931); for abstract see *Ceram. Abs.*, **10** [5], 359 (1931). W.W.M.

Quartz properties for Dinas manufacture. A. BRABEC. *Trans. Czechoslo. Ceram. Soc.*, No. 1 (1931).—Coöperating with Beneš, B. tested pebble flint, silurian quartz, and

tertiary quartz. He summarizes the results of the tests as follows: (1) The period of change of the different tested types into steady modifications of quartz is not uniform, whereas the modification of silurian quartz and of pebbles is slower and takes place within wider temperature limits. The change of tertiary quartz is more rapid and takes place within smaller temperature limits. Results obtained show that in all cases important crystalline changes take place only at temperatures above 1300°C. (2) The total growth of the different raw materials is not uniform after attaining the same specific weight. The smallest growth was found in the case of tertiary quartz and corresponded almost entirely to theoretical formula. (3) Crushing the quartz not only gives it more rapid modification in heat, but also changes the dilatation (heat expansion) so that the same raw material when ground, and if fired to the same specific weight, shows a smaller increase than if it were unground. Crushing is more advantageous in the case of silurian quartz and pebbles than in the case of tertiary quartz. (4) In view of points 2 and 3 it is impossible to make reliable conclusions as to the increase of volume on the basis of specific weight as the initial raw matter and manufacturing method must be taken into account. The silicates present also may increase somewhat the specific weight of the produced Dinas. The determination of specific weight, therefore, is not as important as was supposed. Some phenomena occurring in the course of the tests must be studied in a more systematic manner. R.B.

Sand as an ingredient of the batch composition for silica brick. P. P. BUDNIKOFF AND I. C. SMELJANSKY. *Glastech. Ber.*, **8** [7], 393–98 (1930); see also *Ceram. Abs.*, **9** [11], 941 (1930). E.J.V.

Minimum voltage to reduce aluminium oxide. A. B. NEWMAN AND G. G. BROWN. *Ind. Eng. Chem.*, **22** [9], 995–1000 (1930).—The specific heat of crystalline alumina has been determined by a method involving the diffusion of heat through a cylinder of the powdered material. The results of this determination have been combined with the thermodynamic properties of alumina to compute the minimum theoretical voltage required to reduce alumina to molten alumina and gaseous oxygen. It is probable that this value is reduced in the commercial process by oxidation of the carbon anode. Making allowance for this reduction in potential, the theoretical minimum voltage at 950°C is computed to be 0.947. R.G.M.

Silica brick manufacture. F. REINHART. *Refrac. Jour.*, **7** [4], 264 (1931); for abstract see *Ceram. Abs.*, **10** [2], 125 (1931). E.P.R.

Examination of refractory products. M. LEPINGLE. *Rev. mat. constr. trav. pub.*, No. 257, p. 24*B* (1931).—It is impossible to determine the P.C.E. of refractories from their chemical composition but the temperature at which refractories will fail under rapid heating may be estimated from flux content and SiO_2/Al_2O_3 ratio. The use of broken brick for grog is recommended. See also *Ceram. Abs.*, **10** [6], 432 (1931). M.Y.H.

Testing refractories. H. FORESTIER. *Refrac. Jour.*, **7** [4], 264 (1931); for abstract see *Ceram. Abs.*, **10** [6], 432 (1931). E.P.R.

Furnace refractories. II. W. J. REES. *Blast Fur. Steel Plant*, **19** [5], 726–28 (1931); for abstract see *Ceram. Abs.*, **10** [6], 434 (1931). E.J.V.

Care and maintenance of fuel-fired furnace linings in the nonferrous foundry. H. E. WHITE. *Trans. Amer. Foundry Assn.*, **38**, 644 (1930); for abstract see *Ceram. Abs.*, **9** [9], 747 (1930). (*Trans. Ceram. Soc.* [Eng.])

Refractory blocks. O. LECHER. *Refrac. Jour.*, **7** [4], 264 (1931); for abstract see *Ceram. Abs.*, **10** [1], 39 (1931). E.P.R.

Development of tank-block production. HANS HIRSCH. *Keram. Rund.*, **38**, 291–95, 312–15, 343–46 (1930).—A number of commercially made tank blocks were divided into two classes, (1) those with Al_2O_3 content less than 27%, and (2) those with Al_2O_3

content higher than 27%. Besides chemical analyses, physical tests for specific gravity, porosity, compressive strength, abrasive hardness (resistance to wear), resistance to thermal shock, resistance to glass attack and to sodium carbonate attack, and refractoriness were discussed. Although results show ambiguity due to difference in method of manufacture as well as composition it is concluded that low porosity with only fine pores present, high density, uniformity in composition and structure, and high strength give the best tank block and that blocks high in Al_2O_3 give better resistance to glass attack than those low in Al_2O_3. Homogeneity and low porosity in high Al_2O_3 blocks are especially necessary to avoid the throwing of highly insoluble stones into the molten glass. See also *Ceram. Abs.*, **9** [10], 852 (1930). H.I.

Refractory maintenance cements in the nonferrous foundry. H. E. WHITE. *Trans. Amer. Foundry Assn.*, **38**, 654 (1930); for abstract see *Ceram. Abs.*, **9** [9], 744 (1930). (*Trans. Ceram. Soc.* [Eng.])

Compounding refractory cements. H. T. COSS. *Ceram. Age*, **17** [1], 11–14 (1931).—The present trend is away from an "all-purpose" cement and toward cements to meet specific service and to withstand the maximum operating temperature without appreciable shrinking, cracking, or loss of rigidity. Seventy to eighty-five per cent of dense, strong, sintered aggregate is usually used. Silicate of soda is used where a cold, hard air set is desired. Where silicate of soda content is high, the cements are semi-refractory adhesives rather than refractory cements. The factors involved in a refractory cement composition are as follows: (1) amount and kind of aggregate: calcined fire brick, ground fire brick, pulverized silica, chrome ore, fused alumina, silicon carbide, mullite, etc.; (2) screen size of aggregate: adjusted for thick or thin joints, wash coating, patching, ramming, etc.; (3) amount and kind of clay: adjusted to give maximum workability, long bonding range, low shrinkage, good suspension, etc.; (4) amount and kind of cold setting agent: adjusted for either maximum adhesive cold, or mild adhesiveness hot and cold with maximum temperature resistance. Alkali ratio and Baumé degree must be selected to fit conditions. Control tests on dry cements are made on the following properties: (1) settling behavior, (2) water content, (3) modulus of rupture, dried at 212°F, (4) linear shrinkage, wet to dry, (5) modulus of rupture after firing to 2250°F, (6) linear shrinkage, total after firing to 2250°F. Illustrated. R.G.M.

Manufacture of heat and acid-proof products free from grog. P. P. BUDNIKOFF, S. GICHAREVITSCH, AND I. G. SCHACHNOVITSCH. *Ukrainian Chem. Jour.*, **5**, 93–104 (1930); *Refrac. Jour.*, **7** [4], 264 (1931); for abstract see *Ceram. Abs.*, **10** [3], 194 (1931) E.P.R.

Sagger manufacture. WILHELM NEIDHART. *Keram. Rund.*, **38**, 490–92 (1930).—The steps in the production of saggers for various shapes of ware are described briefly H.I.

New sagger clay. GUSTAV KOPKA AND FRIEDRICH KAPP. *Keram. Rund.*, **38**, 256–57 (1930).—The results of chemical analysis, mineral composition, sieve analysis, and drying and firing properties of a new sagger clay designated as sagger clay "F," produced by the Wildstein-Neudorfer Tonwerke A.-G. are given. The low drying and firing shrinkage and high softening point indicate that it will make a good sagger clay of fairly low plasticity. H.I.

Resistance of refractories. ANON. *Blast Fur. Steel Plant*, **19** [5], 728 (1931); for abstract see *Ceram. Abs.*, **10** [3], 196–97 (1931). E.J.V.

Refractory compositions. E. STEINHOFF. *Refrac. Jour.*, **7** [4], 264 (1931); for abstract see *Ceram. Abs.*, **9** [6], 435 (1930). E.P.R.

Refractory materials. III. H. J. VAN ROYEN AND H. GREWE. *Refrac. Jour.*, **7** [4], 264 (1931); see also *Ceram. Abs.*, **10** [5], 356 (1931). E.P.R.

Thermal expansion of refractory materials. R. V. WIDEMANN, A. JOURDAIN, AND

H. CASSAN. *Céramique*, **33**, 239–56 (1930); for abstract see *Ceram. Abs.*, **10** [3], 236 (1931). (*C.A.*)

Thermal conductivity of refractories. H. GOLLA AND H. LAUBE. *Refrac. Jour.*, **7** [4], 264 (1931); for abstract see *Ceram. Abs.*, **10** [2], 120 (1931). E.P.R.

Supplement to "Heat conductivity measuremeats in refractory materials." MARG. FRITZ-SCHMIDT AND G. GEHLHOFF. *Glastech. Ber.*, **8** [6], 367 (1930).—A brief addition to the original paper, for abstract of which see *Ceram. Abs.*, **10** [6], 433 (1931). E.J.V.

Tensile strength of refractories. H. HIRSCH. *Refrac. Jour.*, **7** [4], 264 (1931); for abstract see *Ceram. Abs.*, **10** [3], 198 (1931). E.P.R.

Use of cork in the power plant. JOHN KELLY. *Eng. & Finance*, **23** [4], 108–10 (1930).—K. describes the production, properties, and use of insulating brick made up of diatomaceous earth, clay, and ground cork that withstand temperatures of 2500°F back of refractories. Illustrated. R.G.M.

Ohio refractories meeting. ANON. *Brick Clay Rec.*, **78** [9], 498–500 (1931).—At the Oak Hill meeting of the Refractories Division, Ohio Ceramic Industries Assn., April 14, 1931, the discussion included dry-press studies, manufacturing practice, raw material control, making difficult shapes, and future research plans. E.J.V.

BOOK

Refractory clays in Calhoun and Pike Counties, Illinois. J. E. LAMAR. Ill. Geol. Surv., *Rept. of Invest.*, No. 22 (1931).—Flint clays occur near Belleview in northern Calhoun County and near Hardin in central Calhoun County. They apparently occupy depressions in Burlington limestone. The two exposures observed exhibit two kinds of flint clays, an upper buff clay and a lower dark gray clay. The latter clay is highly refractory and comparable to the best Missouri smooth flint clays. The upper buff clays are somewhat less refractory. A.A.

PATENTS

Refractory. PAUL G. WILLETTS. U. S. 1,802,296, April 21, 1931. The method of making refractory bodies composed mainly of artificial mullite ($3Al_2O_3 \cdot 2SiO_2$) in homogeneous combination with a relatively small amount of glassy matrix, and having a dense internal structure, which comprises the steps of grinding a natural mineral containing hydrated aluminium oxide to impalpable fineness, grinding a natural siliceous clay to impalpable fineness, the fineness of such grinding enabling the ingredients to combine with substantial homogeneity, intimately mixing the ingredients in selected proportions and in the presence of water, firing the mixed materials to a temperature sufficient to cause the siliceous and aluminous material to combine ceramically to produce mullite ($3Al_2O_3 \cdot 2SiO_2$), reducing the material to sufficient fineness to form a grog, assembling the grog with additional mixed raw material similar to that from which the grog was made, to provide a dry mass insufficiently plastic to be molded by ordinary wet molding methods, forming the assembled materials into the final shapes desired by dry pressing, and firing the articles so produced to a temperature sufficient to cause the added siliceous and aluminous material to combine to produce mullite ($3Al_2O_3 \cdot 2SiO_2$) and to destroy the identity of the original starting materials.

Refractory. PAUL G. WILLETTS. U. S. 1,802,297, April 21, 1931. The process of making refractory bodies composed mainly of mullite ($3Al_2O_3 \cdot 2SiO_2$) in homogeneous combination with a small amount of glassy matrix, which comprises grinding a natural mineral containing hydrated aluminium oxide and a natural siliceous clay to such fineness as to enable the ingredients to combine with substantial homogeneity, intimately mixing the ingredients in selected proportions and in the presence of water, drying the mixed material to a degree of dryness suitable for pressing, pressing the dried material into articles of the shape desired for use, and heating the pressed articles to a temperature

below the melting point of the mullite but high enough to induce the formation of the mullite and the matrix and to destroy substantially all identity of the starting materials.

Refractory. PAUL G. WILLETTS. U. S. 1,802,298, April 21, 1931. A refractory body made by firing a mixture of a previously fired bauxitic clay grog and a binder containing bauxitic clay and diaspore.

Base for furnaces, tanks, etc. JOHN B. FITZ-GIBBON. U. S. 1,804,407, May 12, 1931. A bottom for containers of molten materials, including blocks arranged in series of superposed horizontal courses and the blocks having their sides formed to coöperate with the sides of blocks of an adjacent course for interlocking the blocks of one course with those of another course.

Furnace block. ROLFE SHELLENBERGER. U. S. 1,804,957, May 12, 1931. A furnace wall comprising blocks, each having a metallic backing, refractory facings supported on the backings forming the face of a combustion chamber and covering the backings and shielding same from the heat of the furnace, a layer of relatively low heat-conductive material located between each backing and refractory facing whereby the rate of heat transfer between the backings and refractory facings is reduced so as to permit a high surface temperature on the side of the facings toward the furnace and relatively low temperature of the metal of the backing.

Refractory materials. METALLGES. A.-G. Brit. 340,487, Sept. 23, 1929. (*B.C.A.*)

Refractory goods from molten magnesia. UNION FOR CHEMICAL AND METALLURGICAL PRODUCTION ÚSTÍ ON ELBE. Czechoslo. 27,569. The mass contains a small portion of Al_2O_3, TiO_2, Z_2O_3, or Cr_2O_3. R.B.

Refractory masses from molten clay. UNION FOR CHEMICAL AND METALLURGICAL PRODUCTION ÚSTÍ ON ELBE. Czechoslo. 29,326. Molten refractory substances and flux are added to the clay. R.B.

Terra Cotta

Salt glaze. W. SCHUEN. *Keram. Rund.*, **38**, 261–64 (1930).—The article is a review of papers by Neumann and Fischer (see *Ceram. Abs.*, **8** [12], 899 (1929); **9** [1], 48 (1930)) on the reactions during salt glazing with some additional photomicrographs at low magnifications to show different types of salt glazes and the bleached zone at the contact of body and glaze. H.I.

Firing coping stones. JOS. MATĚJKA. *Stavivo*, p. 735 (1930).—M. proves by a series of tests, that covering stones fired at 800 to 850 °C show a greater water tightness than those baked at 900 to 1000 °C, the usual firing temperature in brick manufacture. The lower firing temperature reduces the inner stresses of products. R.B.

Manufacture of marbles and dice. HERMANN KRUG. *Keram. Rund.*, **38**, 264–65, 284–85, 332–33, 346–47 (1930).—A detailed description is given of the manufacture of marbles and dice including the manufacture of the forms, the washing of the clay, and the forming, drying, coloring, and firing of the marbles. H.I.

Stoneware in the chemical industry. F. WEINREB. *Chem. & Ind.*, **50** [11], 213–14 (1931).—A brief outline of ceramic products is followed by a comparison of chemical stoneware with steatite. Efforts have been made by the ceramic industry to meet the demands of the chemical industries in the following points: (1) increase of mechanical strength, (2) chemical resistance, (3) heat resistance, (4) ability to resist changes in temperature, (5) density or nonporosity, and (6) manufacture of special shapes. Porosity and glazing of chemical stoneware are discussed. G.R.S.

Prevention of crazing in earthenware and faience manufacture. FRITZ ALZNER. *Keram. Rund.*, **38**, 295–96 (1930).—A few empirical experiments are described to dis-

cover a clay suitable for a faience body fired to cone 08 which will carry a tin oxide glaze without crazing. H.I.

Production of sanitary ware. P. REHAUS. *Keram. Rund.*, **38**, 251–54, 266–67 (1930).—In Germany clay sanitary ware is of three types: (1) The hard earthenware body consists of about 50% white firing clay substance, 45% quartz, and 5% feldspar is fired to cones 7 to 9, glazed with a transparent fritted glaze containing enough cobalt to counteract the yellow tint of the bisque, and fired in a glost kiln to cones 3 to 5. (2) The simpler fireclay type is composed of 45 to 55% refractory clay material and the rest grog, covered with a white porcelain engobe and this again with a porcelain glaze, and then fired once to cones 8 to 10. All types of sanitary ware including bathtubs are made by this method. (3) The third type is made from white-firing, highly refractory clays covered with a tin-oxide glaze applied when the body is hard and fired once to cones 8 to 10. Such ware may be either cast or handmade. The manufacture of the third type including selection and preparation of the clays, addition of the necessary electrolyte for casting, drying, preparation and application of the glaze, and firing is described in detail. H.I.

Color fiesta in Santa Barbara. J. E. SIMONS. *Amer. Painter & Decorator*, pp. 36–39 (March, 1931).—The Court House of Santa Barbara is described. (*D.I.*)

Modern church. ANON. *Arch. & Bldg.*, **58** [2], 56 (1931).—The first Swedish Baptist Church has its exterior developed from Swedish origins. The façade is of light brick rising from corner stones of black granite. The vestibule walls are of well-laid brick and on the ceiling is a painting done in pure fresco technique. Lower walls are of brick below the balcony and above of rough buff-colored plaster. The coloring is light. The balcony rail, decorated in light blue and buff, is done in Al Secco technique lime color on dry plaster. E.P.R.

"Everyman House"—Drage's, Ltd. ANON. *Anglo-Amer. Trade*, pp. 119–24 (March, 1931).—This article deals with the architecture of the modern store. (*D.I.*)

Modern department store. ANON. *Merchants Rec. & Show Window*, pp. 9–12 (March, 1931).—The third store of "De Bjenkorf, Ltd.," in Rotterdam is described. Illustrated. (*D.I.*)

Present day architecture in Japan. RICHARD J. NEUTRA. *Form*, pp. 22–27 (Jan. 15, 1931).—Earthquakes are a factor in architectural development in Japan. (*D.I.*)

BOOKS

New World Architecture. SHELDON CHENEY. Longmans, Green & Co., London, 1930. 400 pp. Price $10.00. Illustrated. (*D.I.*)

Terra Cottas from Nippur. LEON LEGRAIN. Univ. of Pa. Press, Philadelphia, 1931. 52 pp., 72 plates. Price $12.50. Reviewed in *Times Lit. Supp.*, **30**, 155 (1931).—This is a publication of the Babylonian Section of the Pa. Univ. Museum. H.H.S.

White Wares

Method for eliminating water marks from tableware. G. A. BOLE. *Jour. Amer. Ceram. Soc.*, **14** [6], 454–56 (1931); for abstract see *Ceram. Abs.*, **10** [5], 364 (1931).

Effect of furnace atmospheres on the quality of certain types of glazes. ARTHUR P. WATTS. *Jour. Amer. Ceram. Soc.*, **14** [6], 460–68 (1931).

Pottery engineering; its failures and possible improvements. WILLIAM PODMORE. *Pottery Gaz.*, **56** [647], 707–708 (1931).—P. endeavors to point out why mechanical means in pottery production have not advanced proportionately with other industries. He does this by discussing a suitable pottery layout, the sliphouse, blungers, sifters

pumps, magnets, clay presses, pug mills, and motive power, pointing out some of the defects and failures of each that have been discovered and suggesting possible improvements. E.J.V.

Chemical treatment of clay slip for plastic body. D. H. ROWLAND AND KURT WETZEL. *Ceram. Ind.*, **16** [5], 455–59 (1931).—Rigid plant control is essential to maintain the desired properties in electrical porcelain insulators. The manufacture of insulators at the Locke Insulator Co. is described. The production of a uniform body in the sliphouse is discussed in detail including chemical treatment, *e.g.*, correcting viscosity fluctuations. The raw materials are examined for soluble salt content and the body is kept at a constant plasticity, water content, and shrinkage. W.W.M.

Fastening wall tile. KAREL HINEIS. *Stavivo*, p. 587 (1931); *Trans. Czechoslo. Ceram. Soc.*, 1930.—The adhesive force of wall tile on cement mortar after 28 days of setting is as follows: (1) paving tile 1.20 kg./sq. cm., and (2) glazed wall tile 0.45 kg./sq. cm., densely baked porcelain wall plates "Tunelia" 0.80 kg./sq. cm. Undercut grooves in the tile increase the adhesive force, *e.g.*, from 0.73 to 0.94 kg./sq. cm. Interstices recommended for wall tile are 1.5 to 2 mm. and for Tunelia plates, 3 to 5 mm. Time studies have shown that the loss of time with fastening amounts to about $^2/_3$. H. invented a mounting apparatus weighing about 50 kg. including a small cutting and grinding machine of 34 kw. The tools required for the worker are arranged in convenient drawers. R.B.

Glazes and colors for stove tile. ANON. *Keram. Rund.*, **38**, 231–35 (1930).—A list of suitable glaze compositions and colors to be added to these compositions for glost firing at cones 03 to 01 is given. H.I.

Porcelain condensers for high-frequency telephony. J. WALLICH. *Keram. Rund.*, **38**, 341–43 (1930); *Elec. World*, **97**, 111 (1931).—Condensers for coupling purposes in carrier current systems have been made of porcelain in Germany. They are similar in shape to porcelain insulators. One type for 35 kv. service with 1000-cm. capacity and another for 65 kv. with 2000 cm. capacity are described. The latter has an upper portion consisting of five petticoats and a lower cylindrical portion closed at the bottom. The condenser is made in sections by casting in plaster forms and a final shaping on the wheel. After drying, the upper portion is glazed and the whole shape is fired at about 1400°C. After firing, the condenser is about 160 cm. tall and 50 cm. in diameter. Closely adhering metallic coats, uniform in thickness, are deposited on the inside and outside of the cylindrical portion and the inner layer is connected electrically to a metal cap fitting on the top of the condenser. The condensers are subjected to an electrical test of 163 kv. for the 65-kv. type and 97 kv. for the 35-kv. type and a mechanical pulling test of 500 lbs. between the ends. H.I.

Importance of ceramic materials for sanitary technique. O. KALLAUNER. *Stavivo*, p. 184 (1930).—Clay vessels, especially of porous clay and porcelain, sanitary goods, and stoneware for sewage purposes, etc., are discussed. R.B.

Calculation of patterns. KARL PETER. *Keram. Rund.*, **38**, 249–51 (1930).—Simple rules are given for changing dimensions of patterns of earthenware containers when a change in volume of the container is desired. H.I.

Ceramics in dentistry. A. STEINBERG. *Keram. Rund.*, **38**, 502–504 (1930).—The method of casting a low-melting porcelain in the molten state into molds for the formation of artificial teeth is discussed. The composition of the porcelain is not given. H.I.

Persian bathroom. J. EDWARD TUFFT. *Tiles & Tile Work*, pp. 14–16 (March, 1931).—A beautiful Persian bathroom has been built into the front window of the Building Arts and Crafts building, Los Angeles. (*D.I.*)

Fine merchandise deserves fine settings. MARGARET LANDACRE. *Tiles & Tile*

Work, pp. 8–13 (March, 1931).—Berger-Eldridge, Inc., Los Angeles, has designed a unique building for displaying and selling tile. (*D.I.*)

Ceramic digest and forum. T. W. TALWALKAR. *Jour. Indian Ceram. Soc.*, **3** [1], 39 (1931).—A discussion is given on the "Investigation of Feldspar and Its Effect in Pottery Bodies," by R. F. Geller and H. S. Creamer (see *Ceram. Abs.*, **10** [2], 128 (1931)). A.A.

PATENTS

Displaying tile, etc. ROYDEN M. ZIEGLER, ARIO PARDEE, AND HERBERT W. WARDEN, JR. U. S. 1,802,102, April 21, 1931. An apparatus for displaying tile, etc., comprising a wall having an opening therein, overhead stationary tracks behind the wall, trolleys adapted to engage the tracks, a series of panels suspended from the trolleys, a support leading to the wall opening, and a transfer carrier movable on the support parallel with the stationary tracks, the transfer carrier including a track adapted to register with any of the stationary tracks, whereby any of the panels may be transferred from its stationary track to the wall opening.

Making porcelain. ALICE MAUDE FAIRCHILD AND EMORY LEE RATHBURN. U. S. 1,802,641, April 28, 1931. An improved porcelain comprising clay, zirconium, and refractory neutral compounds of phosphorus.

Flashing clay products. FORREST K. PENCE. U. S. 1,802,776, April 28, 1931. The process of manufacturing flashed, unglazed, clay articles containing oxides, the process consisting in confining the articles in a refractory container with an oxide-reducing agent and a diluent pulverized refractory mineral and subjecting the container to a firing action in a kiln, thereby liberating the gases of the reducing agent.

Insulating bodies and insulators for spark plugs. REINHOLD REICHMANN. U. S. 1,803,355, May 5, 1931. The process of producing insulating bodies of aluminium oxide, particularly spark plugs, which consists in sintering the bodies in a chamber free from reducing carbon-containing gases or vapors.

Clay product, ceramic composition, and associated processes. THOMAS S. CURTIS. U. S. 1,803,999, May 5, 1931. A ceramic composition for strengthening clay products which comprises a mineral product of fibrous crystalline structure obtained by heat treating a fibrous aluminium silicate mineral to a temperature of from approximately 1700°F to approximately 1800°F.

Water closet bowl. BERT O. TILDEN. U. S. 18,065, May 12, 1931 (reissue).

Supporting device for pottery. BENJAMIN D. HARDESTY. U. S. 1,804,980, May 12, 1931. A supporting device for pottery ware consisting of a tripod-shaped triple arm body of skeleton form having upwardly sloping ends with downwardly extending pedestals each provided with an upper socket and a lower lug and having on the upper face of each arm a depressed rectangular-shouldered bearing face for a separable ware-supporting abutment, and an elongated abutment therein having a flat base seated in the bearing face with clearance at the ends and sides.

Equipment and Apparatus

Notes on adiabatic calorimetry. I. Temperature changes of the order of 1°. E. LANGE AND E. O. ROUNSEFELL. *Z. phys. Chem.*, **142***A* [5], 351–64 (1929).—A set-up which increases the accuracy of measurement of heat changes is described. The apparatus includes (1) a mercury thermometer graduated to 0.01° and 0.001° for the measurement of temperatures, (2) protected heating element in a glass capillary, (3) improved electrical watch for recording the time, (4) small electrical speed regulator to

control the stirrer so that the energy input is constant, (5) improvement of the whole apparatus to prevent effects of exterior temperature changes, and (6) notes on some calorimetric changes which may occur due to vaporization or condensation caused by vapor-pressure changes due to changes in concentration, adsorption phenomena, and temperature changes. **Nonisothermal-adiabatic calorimetry. II.** E. LANGE AND K. P. MISCENKO. *Z. phys. Chem.*, **148** [3], 161–76 (1930).—Description of a calorimeter by which it is possible, by a relatively simple method with the use of a Beckman thermometer graduated to 0.001°C, to measure thermal changes of less than 0.1° with an accuracy of 0.0001°. **Adiabatic calorimetry. III.** E. LANGE AND J. MONHEIM. *Z. phys. Chem.*, **149** [1], 51–88 (1930).—The theory underlying adiabatic calorimetry is discussed. A description of a calorimeter for the measurement of very small thermal changes, $\Delta T = 10^{-3}$ to 7.10^{-7} degrees with an accuracy of 5.10^{-6} degrees is included. L.T.B.

Methods for testing breaking strength of irregular plates. E. ALBRECHT. *Keram. Rund.*, **38**, 403–404, 438–39 (1930); for abstract see *Ceram. Abs.*, **9** [9], 758 (1930). H.I.

Sandblast methods and equipment. II. C. J. STIERS. *Metal Cleaning & Finishing*, **3** [4], 343–44 (1931); for Part I see *Ceram. Abs.*, **10** [6], 445 (1931). E.J.V.

Defects from corroding slip lines. PAUL TEETOR. *Ceram. Age*, **17** [3], 142 (1931).—Pinholes result from small air bubbles in the slip due to air seeping through a pinhole in the pipe line between the suction side of the slip and the slip storage tank or to a loose connection. If the air particle is so small that it cannot rise to the surface, it produces a pinhole. Iron pipe may produce specking due to corrosion. Slip contains electrolytes and moves sluggishly. With a cobalt salt body stain, blue specking is caused by electrolytic deposition of cobalt on the surface of the pipe and subsequent flaking off. Lead lining of the pipes is recommended due to its low cost and low solution pressure. If properly installed, there are no iron surfaces in contact with the slip at the end of each pipe length. There is less tendency for the slip to form nodules on the lining of the pipe. The fact that the inner surface of the pipe remains clean reduces the friction of the slip following through the line. Frequent washing of the lines is unnecessary. R.G.M.

Dust collectors. ANON. *Times Eng. Supp.*, **27**, 457 (1931).—The National Council of the Pottery Industry is considering the possibility of installing apparatus to comply with government regulations that dust discharged from exhaust fans shall be collected and not allowed to escape into the air. Manufacturers are also urged to experiment with finely-ground china pitchers or with whiting as a substitute for flint in the polishing process. H.H.S.

Dust control in phosphate rock grinding. W. H. GABELER. *Ind. Eng. Chem.*, **22** [10], 1077–81 (1930). R.G.M.

Dust removal from chimney gases. ANON. *Queensland Mining Jour.*, **32** [3], 103 (1931).—Seventy-five power stations are already equipped in Great Britain with a patent type of centrifugal dust collector which removes 70 to 95% of the total dust. E.P.R.

Carl Zeiss polariscope. ANON. *Glass Ind.*, **12** [5], 115 (1931).—This tester for strained glass is a polarization apparatus that makes visible the double refraction of light in stressed glass. The construction details and operating principles of the apparatus are described. Illustrated. E.J.V.

Electric weight car for collecting glass batch. ANON. *Nat. Glass Budget*, **47** [1], 10 (1931).—An electrical motor-driven weight car for collecting glass batch which carries interchangeable hoppers of 2800-lb. capacity has been developed by the Stephens-Adamson Mfg. Co. E.P.R.

Increasing belt conveyer life. W. E. PHILIPS. *Brick Clay Rec.*, **78** [8], 452–54

(1931).—Five simple things that materially increase the life of belt-conveyer installations are (1) lubrication, (2) cleanliness, (3) loading, (4) wear, and (5) training the belt. These points are enlarged upon. E.J.V.

Link-wedge belt. ANON. *Chem. Met. Eng.*, **38** [3], 167 (1931).—The construction of a new belt made by the Dayton Rubber Mfg. Co., Dayton, Ohio, is described. It can be made in any desired width and length. The metal clamps which are used to join the ends are also shown. G.R.S.

CO_2 indicator and recorder. ANON. *Chem. Met. Eng.*, **38** [3], 167 (1931).—Re-design of the Ranarex CO_2 indicator and recorder has been announced by the Permutit Co., New York. A description and disassembled view of the recorder are given. These machines are available for determination of the composition of other gases as well as recording of specific gravity. G.R.S.

Clayworking machine. ANON. *Brit. Clayworker*, **39** [467], 454 (1931).—This machine (German made) consists of a revolving plate, underdriven by rack and pinion, a stationary fender to contain the clay, and a screw conveyer which discharges the clay from the machine. The speed of the machine is so arranged that the material to be mixed remains about 10 min. in the machine, and by this means is subjected to a far more prolonged mixing than in any other. It is specially designed to work in conjunction with a pan mill and it is particularly suitable for receiving the product from a pan mill and passing it to the crushing rolls of the brick machine. The new machine has the advantage of being able to mix two or three clays or clay and sand added one after another to a thoroughly uniform mix. The machine requires only 3 h.p. to drive it. The low power factor is due to the fact that the wet pan delivers the material in small quantities at a time on the revolving plate. R.A.H.

Recent developments in ball mills. J. WINKEL. *Rock Prod.*, **34** [8], 84–85 (1931); for abstract see *Ceram. Abs.*, **10** [5], 369 (1931). W.W.M.

Grinding improved by mills of new design. L. T. WORK. *Chem. Met. Eng.*, **38** [4], 228–29 (1931).—Various types of mills and air separators are described. G.R.S.

Grindability machine. ANON. *Chem. Met. Eng.*, **38** [3], 167 (1931).—For comparing the relative ease of grinding of various materials, the Whiting Corp., Harvey, Ill., has developed a "grindability machine," of the mortar and pestle type. In a constant number of strokes, a constant weight of material being tested is pulverized. The product is screened and a method of calculating the percentage of "grindability" is outlined. G.R.S.

Constant-weight feeder. ANON. *Chem. Met. Eng.*, **38** [3], 167 (1931).—Type D is a heavy-duty constant-weight feeder with capacities ranging from 10 to 1000 T. per hour to handle material ranging from very fine powder to lumps as great as 5 in. in diameter. Operation of the machine is described. It is manufactured by Hardinge Company, York, Pa. G.R.S.

Heavy-duty apron feeder. LINK-BELT CO. *Brick Clay Rec.*, **78** [9], 504 (1931).—A feeder suitable for handling either abrasive or nonabrasive material containing lumps of $^1/_4$-in. size and smaller, up to 6-ft. dimensions, being especially well adapted to the handling of extremely heavy, large, lumpy, and abrasive materials is announced. Illustrated. E.J.V.

Scraper. R. H. BEAUMONT CO. *Brick Clay Rec.*, **78** [9], 504–506 (1931).—An electric, automatic remote control drag scraper hoist of new design, having several exclusive features is announced. E.J.V.

Tests on direct heat driers. R. K. HURSH. *Clay-Worker*, **95** [4], 258–62 (1931).—The equipment of the Chicago Brick Co. and its operation are described. Drying conditions, air distribution, air pressures, and moisture content of the ware at various points in the tunnels are discussed. Considerable data are presented in tabular form and

a series of conclusions based on the various operating conditions tried are set forth. E.J.V.

Suiting drying machinery to continuous processes. A. O. HURXTHAL. *Chem. Met. Eng.*, **38** [4], 230–32 (1931).—The complexity of drying on a continuous basis is outlined. Requirements of a drier are (1) continuous operation, (2) large drying capacity per cubic foot and per square foot of floor space, and (3) constant and accurate control. Different kinds of driers are described and illustrated by diagrams. G.R.S.

Oil engine drive in brickworks. II. ANON. *Brit. Clayworker*, **39** [467], 445–46 (1931).—Precautions are given which should be observed in starting up oil engines. Forced lubrication is discussed and some reasons listed for engines failing to start promptly. Maintenance, valve setting, and necessity of attention to cooling system are discussed. For Part I see *Ceram. Abs.*, **10** [6], 446 (1931). R.A.H.

Apparatus for cutting brick, etc. P. RENAULT. *Rev. mat. constr. trav. pub.*, No. 257, p. 29*B* (1931).—Vertical pug mills, methods of gearing, and operation are described. Illustrated. See also *Ceram. Abs.*, **10** [2], 129 (1931). M.Y.H.

Smoke recorder. LEEDS & NORTHRUP CO. *Rock Prod.*, **34** [9], 110–11 (1931); for abstract see *Ceram. Abs.*, **10** [5], 371 (1931). W.W.M.

Thermal control apparatus. O. PŘIDAL. *Stavivo*, p. 503 (1930); *Trans. Czechoslo. Ceram. Soc.*, No. 1 (1930).—Among others, P. describes an apparatus for rapid analysis of smoke gases designed by F. Staněk. This apparatus is based on the principle of gas absorption by chemical agents. It is provided with a gas sucking device, works without pressure water, and is driven by a small electric motor. R.B.

Rationalization of production through efficient coördination of material-handling equipment. ANON. *Ceram. Ind.*, **16** [5], 438–41 (1931).—Material-handling equipment is discussed and illustrated, and the importance of coördination of equipment for efficient material handling is pointed out. Various types of conveyers, etc., are described. W.W.M.

Unloading, distributing, and reclaiming system for silos or standard bins. R. F. BERGMANN. *Rock Prod.*, **34** [9], 108–109 (1931).—B. describes and illustrates an unloading device for silos, bins, and cars. It will handle loose bulk material from box cars at the rate of 10 to 15 T. per hour. W.W.M.

Photoelectric cell and electric clock record daily hours of bright sunshine. WALLACE A. THOMSON. *Can. Jour. Research*, **4** [3], 299 (1931).—A method is presented whereby an accurate record of the daily hours of bright sunshine is made by an electric clock, controlled through a relay by the intensity of the light incident upon the cathode of a suitably exposed photoelectric cell. W.L.

Filters for the reproduction of sunlight and daylight and the determination of color temperature. RAYMOND DAVIS AND K. S. GIBSON. *Chem. News*, **142** [3704], 225–26(1931).—The method of making filters for use in photography, colorimetry, and photometry is given. G.R.S.

Pocket-size circular slide rule with 50-in. scale. ANON. *Eng. News-Rec.*, **106** [17], 709 (1931).—By coiling the scales four times around concentric disks, the equivalent of a 50-in. slide rule has been produced in an instrument small enough to be carried in the coat pocket. All the usual scales are provided. W.L.

Ceramic industries modernize. ANON. *Chem. Met. Eng.*, **38** [4], 217–18 (1931).—Design as an active topic in ceramic industries is shown by improvement of firing methods and equipment, particularly in the tunnel kiln. Mechanical forming has been a field for new and better methods. Continuous driers have come into use. The introduction of the diamagnetic separator in the feldspar field is an outstanding development. G.R.S.

Magnetic purification of ground feldspar. ANON. *Queensland Mining Jour.*, **32**

[3], 104 (1931).—Magnetic methods for the purification of ground feldspar are described. The induction separator almost completely removes all contaminating materials from the raw feldspar. E.P.R.

Refinements in design for mechanical separation. ANTHONY ANABLE. *Chem. Met. Eng.*, **38** [4], 220–23 (1931).—Classification, sedimentation, filtration, centrifuging, and screening are treated. G.R.S.

Magnetic separator pulley. CUTLER-HAMMER, INC. *Brick Clay Rec.*, **78** [9], 504 (1931); *Pit & Quarry*, **22** [3], 77 (1931).—The new pulley has only three major parts, a machined cast steel spool, the magnet coils, and a coil shield, with the necessary insulation. Illustrated. E.J.V.

Magnetic separation of nonmetallic materials. ANON. *Pit & Quarry*, **22** [2], 78 (1931).—Research engineers of the Magnetic Mfg. Co. have perfected an induction separator which provides efficient magnetic separation of so-called nonmagnetic material and the highest intensity magnetic separator of the usual type. Its construction is such as to provide intense magnetic pull with low power input and correspondingly low current consumption. Materials such as feldspar, dolomite, gypsum rock, glass sand, and abrasives are now amenable to magnetic separation with this unit. E.P.R.

Induction regulator compared with other means of regulation. I, II, III. ANON. *Eng. & Finance*, **22** [2], 53–54; [3], 78–79; [4], 109–11 (1930).—A complete discussion of feeder-voltage regulation is given. R.G.M.

Manometer type instrument indicates pressure and flow at same time. ANON. *Eng. & Finance*, **17** [3], 82 (1930).—The resultant of differential pressures indicates the average line pressures; their difference indicates the rate of flow. R.G.M.

Pulverizer has simple grinding principle. ANON. *Eng. & Finance*, **23** [6], 199–200 (1930).—Type B pulverizer of the Fuller-Lehigh Co., Fullerton, Pa., is described. R.G.M.

Pulverizer development. P. A. HIRSCH. *Eng. & Finance*, **23** [6], 198 (1930).—H. describes the Uni-Flo pulverizer for pulverizing coal. R.G.M.

Pyrometry in porcelain enameling. II. ANON. *Better Enameling*, **2** [3], 21–27 (1931).—The construction and operation of the disappearing filament optical pyrometer and the radiation pyrometer as used in enameling are described and diagrams are included. W.C.O.W.

New pyrometer. UEHLING INSTRUMENT CO. *Eng. & Finance*, **23** [2], 50 (1930); see also *Ceram. Abs.*, **10** [3], 210 (1931). R.G.M.

Equipment at Ford Motor Co. Rouge plant. ANON. *Eng. & Finance*, **24** [2], 53–56 (1931).—The meters and automatic control equipment at the Ford Motor plant are described. See also *Ceram. Abs.*, **9** [5], 343 (1930). R.G.M.

High-temperature lubricants. ANON. *Ceram. Ind.*, **16** [5], 475 (1931).—The Acheson Oildag Co., Port Huron, Mich., produces high-temperature lubricants of electric-furnace graphite in the colloidal state diffused in mineral oil, castor oil, or water. W.W.M.

Prioform heat insulation. ANON. *Engineering*, **131** [3405], 522 (1931).—The system of insulation for high-pressure steam pipes and other apparatus developed by the Deutsche Prioform Werke, G.m.b.H., Cologne, is discussed. A.A.

Electrical deck machinery. ANON. *Engineering*, **129**, 483 (1930).—Advances made in electrically-driven deck machinery which is reliable and flexible in operation are set forth. A.A.

Standardization of a modified Ostwald viscometer. H. M. CHADWELL AND B. ASNES. *Jour. Amer. Chem. Soc.*, **52** [9], 3493–3507 (1930).—Three viscometers of the Ostwald type, as modified by Washburn and Williams, which were constructed similarly with the exception of the configuration of the ends of the capillaries, which varied from

gradual trumpets to squarely fractured ends, are described. The dimensions of these viscometers were determined as accurately as possible. The time of flow with water was determined with the three instruments at 15, 18, 20, 22, 25, 27, and 30°C. In terms of Reynold's criterion, the velocities of flow varied between 25 and 63. R.G.M.

BOOK

Laboratory Manual of Electrochemistry. ERICH MÜLLER. Translated from the 4th German ed. by H. J. T. Ellingham. 363 pp. London, 1931. Reviewed in *Chem. News*, **142** [3703], 222 (1931). G.R.S.

PATENTS

Chuck or holder for turning or treating pottery. H. F. WOOD AND W. COULTER. Brit. 345,240, April 1, 1931.

Drying filter cake. G. W. JOHNSON. Brit. 345,247, April 1, 1931.

Feeding clay, etc., to dies. R. J. EVANS AND E. EVANS. Brit. 346,582, April 22, 1931.

Kilns, Furnaces, Fuels, and Combustion

Advantages of tunnel kiln. PHILIP DRESSLER. *Blast Fur. Steel Plant*, **19** [5], 724 (1931). E.J.V.

Measuring and recording instruments for rotary kilns. I. A. C. DAVIS. *Cement & Cement Mfg.*, **4** [2], 149 (1931).—D. describes methods for making necessary temperature measurements and for analyses of exit gas. W.L.

Use of periodic kiln or continuous kiln for small production. ANON. *Rev. mat. constr. trav. pub.*, No. 257, p. 21*B* (1931).—The criterion in a small brick plant in choice between a periodic or continuous kiln is not cost of firing but rather possibilities of marketing product and local conditions. Use of the periodic kiln is recommended because of its suitability to retarding of production, lack of necessity for storage, and consequent inactivity of capital. M.Y.H.

Ordinary defects in firing brickwork. B. HELAN. *Stavivo*, p. 506 (1930).—Ring kilns frequently are unsatisfactory. The fired goods have a white coating and fuel consumption is too high caused by the wrong size of chimney, smoke flues, and incorrect insulation of walls and bottom part of the kiln. H. gives directions on the basis of experience as director of stoker's courses organized annually by the Brickworks Assn. with the support of the Czechoslo. Ceram. Soc. R.B.

Keeder's kiln and drier. JAROSLAV VOLT. *Stavivo*, p. 417 (1930).—Heat is recuperated in the drier. R.B.

Portable brick kiln with drier. FRANTIŠEK BEZUNK. *Stavivo*, p. 590 (1930).—B. describes a new Czechoslovakian patent of a round portable kiln. In recent years investigators have tried to reduce to a minimum the first cost for erecting kilns (see Habla's patent*). B.'s kiln has no masonry but only lateral protecting walls. In the middle there is an insulating wall. The kiln is provided with external outlets and fan draft. R.B.

Drying apparatus for round kilns. JOS. R. FIALA. *Stavivo*, p. 110 (1930).—F. does not recommend drying means formed by ports which pass through the lateral walls or vault of the kiln, as the walls expand under the heat and then shrink so that the ports need frequent repair. R.B.

Brickwork in Zihli near Plzeň. F. SLAVÍK AND JOSEF PÖSSNER. *Stavivo*, pp. 564–65

* This issue, p. 519.

(1930).—Pössner's drier is a circular drier and is heated by the heat recuperated from the kiln. Drying is a handicap for round kilns because if the waste heat from the kiln is utilized, the kiln forms an organic unit with the drier. Even a kiln which is not thermally satisfactory can offer excellent results when combined with a drier. R.B.

Mechanical stoking devices for round kilns. A. CHMELÍČEK. *Stavivo*, p. 450 (1930); *Trans. Czechoslo. Ceram. Soc.*, No. 1–2 (1930).—The first utilizable mechanical stoker was invented in Czechoslovakia in 1911 in Moravia by Julius Janaszewski and patented in 1912. Other mechanical stokers in Czechoslovakia are (1) A. Chmelíček patented system "Palič" (Czechoslo. 22,224 and 27,817, 1924) whereby fuel is admitted in small portions by a shovel; (2) F. Slavík's system of throwing in fuel by a distributing plate; and (3) O. Kallauner's hand stoker, designed in a manner similar to Slavík's. C. also describes mechanical stokers which are used in other countries. The best stokers are those which are simplest in design and handling. R.B.

Repair of kiln masonry. ANON. *Rev. mat. constr. trav. pub.*, No. 257, p. 27*B* (1931).—Various mixtures suitable for repairing kiln linings are given. The most satisfactory is a mixture of clay and grog, applied by means of a cement gun in three or four layers, allowing for the use of the kiln between the application of each layer. M.Y.H.

Flat crown in ceramic kilns. A. HABLA. *Stavivo*, p. 591 (1930).—The first designer of a flat crown in a ceramic kiln was Ragoucy in 1925. The principal advantages of these crowns are thinner masonry, larger kiln space, more regular work, and lower first costs and repair costs. R.B.

Composition of coal. R. V. WHEELER. *Chem. & Ind.*, **50** [17], 335–44 (1931).—The ultimate compositions of coals are given with graphs showing the "fuel band" and properties of coals of carbon content between 70 and 95%. Excellent photomicrographs of vitrain, fusain, clarain, and durain are given. A chemical examination of coal is discussed and the action of heat on coal is outlined. G.R.S.

Evolution of coal. HENRY BRIGGS. *Chem. & Ind.*, **50** [7], 127–33 (1931).—The formation of coal is traced. Graphs are shown giving the carbon-hydrogen, carbon-oxygen, and oxygen-hydrogen curves. The nature of the debituminization process is discussed and also accelerative and retarding influences. G.R.S.

Coal consumption of various kilns. ANON. *Brit. Clayworker*, **39** [467], 454 (1931).—The following table gives the coal-consumption of kilns of various types. The calorific value or heating power of the fuel is assumed to be 10,850 B.t.u. This table refers to German brick which measure $9^7/_8 \times 4^3/_4 \times 2^1/_2$ in.

Type of kiln	Kind of brick	Coal consumption per 1000 brick (lbs.)
Rectangular updraft	Common	792
Rectangular downdraft	Rustic and facing	1210
Semicontinuous with 2 to 4 chambers	" " "	1100
Continuous chamber with side fire	" " "	814
Continuous chamber with fire steps on partition wall	" " "	704
Continuous chamber with longitudinal fires and bag walls	Best facing	462
Gas-fired continuous chamber for medium output	Rustic and facing	583
Gas-fired continuous chamber for heavy output	Common	473
Simple continuous (Hoffman)	"	253
Simple continuous with grates and automatic stokers without partition walls (Belgian kiln)	"	209

R.A.H.

Reducing fuel consumption in brick kilns. B. HELAN. *Stavivo*, p. 226 (1930).—H. studied 36 round brick kilns in Czechoslovakia. These studies have been carried

out with the help of the Czechoslo. Ceram. Soc. The essential feature for possible economies in fuel is the correct design and handling of the kiln, rapid progress of fire, and a sufficiently long cooling zone. R.B.

Advantages of pulverized coal as fuel. W. N. KELLY. *Mining Ind. Rec.*, **34** [5], 64 (1931).—K. shows the growth of pulverized-coal firing, outlines some of its advantages and lists some necessities for success in its use, and contrasts it with oil firing. E.J.V.

Pulverized fuel firing. ANON. *Chem. News*, **142** [3699], 150–51 (1931).—Examples are given of recent notable power station installations using pulverized fuel. G.R.S.

Device for igniting pulverized fuel. ANON. *Pit & Quarry*, **22** [2], 44 (1931).—Methods commonly employed for igniting pulverized-fuel furnaces are not certain and in many cases accidents have resulted due to explosions or "flare-backs." Liquid fuel is used. A flame is produced which cuts a path across or through the pulverized-fuel stream. The flame length varies from 2 to 12 ft. which is sufficient to ignite any furnace or kiln. Within a minute from lighting the igniter and turning on the powdered fuel the furnace is lighted. E.P.R.

Heat transfer in low-temperature carbonization of coal. V. C. ALLISON. *Ind. Eng. Chem.*, **22** [8], 839–43 (1930); *Gas Age-Rec.*, **66** [14], 496 (1930).—Part of the entering heat raises the coal charge to reaction temperature and the remainder promotes carbonization requiring a definite time to proceed to completion. Heat can penetrate coal layers less than 0.52 in. thick more rapidly than the carbonization reactions can proceed. In carbonizing stationary layers of coal, therefore, the throughput in pounds per square foot of heated surface per hour decreases when the coal layer thickness is less than 0.52 in. Heat enters the coal charge largely by radiation, but is interrupted by the formation of a plastic layer which is relatively impervious to heat penetration either by radiation or conduction. R.G.M.

Behavior of carbonized fuels in an open-fire grate. G. MILNER, J. H. DYDE, AND H. J. HODSMAN. *Chem. & Ind.*, **50** [14], 113–20 (1931).—Particular attention is given the radiation of heat which is found to be dependent on the combined effect of the area of the material radiating, its temperature, and emissivity. The radiant efficiencies and rates of output of heat and ignition temperature of a variety of fuels are tabulated. G.R.S.

Fuel oil and the brick industry. M. I. LUBBOCK. *Brit. Clayworker*, **39** [467], 468–73 (1931); *Rev. mat. constr. trav. pub.*, No. 257, p. 22*B* (1931).—On the direct fuel cost alone for firing so many thousand brick, the latest results indicate that the firing cost itself is higher than with coal. Against this higher direct fuel cost, however, must be set the following advantages: (1) the time of firing can be reduced, thus reducing the overhead costs; (2) the number of underfired brick can be almost entirely eliminated which shows an important saving; and (3) there is a saving in labor of coal and ash handling. L. discusses five types of oil burners. Illustrated. See also *Ceram. Abs.*, **9** [5], 371 (1930). R.A.H.

Natural gas: means and methods of reforming the product. ANON. *Chemicals*, **35** [18], 11–12 (1931).—Recent improvements in the manufacture of gas are discussed. G.R.S.

Density of carbon dioxide. D. L. COOPER AND O. MAASS. *Can. Jour. Research*, **4** [3], 283 (1931).—Determinations of the density of carbon dioxide are shown for five temperatures from $-30°$ to $+77°$C, and are over a pressure range of 760 to 250 mm. of mercury. The extrapolation of these curves to zero pressure shows a mean value for the atomic weight of carbon $= 12.004 \pm 0.003$. A graph is included which shows the apparent molecular weight as a function of the temperature; molecular volumes have been

calculated from this. The results give P.V.T. values for CO_2 in the above temperature and pressure range, with an accuracy considered to be greater than available data. W.L.

Clean coal and better combustion. E. G. HILL. *Eng. & Finance*, **23** [2], 44–49 (1930).—H. discusses the washing of coal. R.G.M.

Calculation of excess air and the influence of steam on combustion. JAN TESAŘ AND JAN PUTTERLÍK. *Stavivo*, p. 57 (1930).—The water penetrating below the grate does not give off calorific heat but transmits it only from the furnace to the kiln and chimney. It cools the grate and avoids firing together of the slag. The steam augments the volume of smoke gases. R.B.

Trends in heat transfer. D. F. OTHMER. *Ind. Eng. Chem.*, **22** [9], 988–93 (1930). R.G.M.

BULLETINS

British Power and Fuel Bulletin. ANON. *Engineering*, **131** [3405], 523 (1931).—A bulletin will be published monthly at the price of 10s for 12 issues, providing selective and up-to-date abstracts of books, papers, and articles on power and fuel under the following main headings: sources, generation, distribution, and storage and utilization. Only matters published in Great Britain will be dealt with. A.A.

Report of the Fuel Research Board for the year ended March 31, 1930. C. H. LANDER. Dept. Sci. Ind. Research [London], 1930; see also *Ceram. Abs.*, **10** [5], 377 (1931). W.L.

PATENTS

Furnace. FRANK W. BROOKE. U. S. 1,802,000, April 21, 1931. In a furnace, a heating chamber integral with the furnace and having a charging opening, a heat-insulated closure in the opening, and sealing means for the chamber exteriorly of the closure and unconnected therewith.

Furnace. FRANK W. BROOKE. U. S. 1,802,001, April 21, 1931. In a furnace, a heating chamber, a roof for the chamber having a plurality of parallel passages formed therein out of communication with the chamber and extending transversely the full width of the chamber, and means for delivering a cooling medium in opposite directions to alternate passages.

Supporting china and earthenware during firing in the tunnel oven or kiln. ARTHUR JOHN CAMPBELL. U. S. 1,802,235, April 21, 1931. The combination, with a heating chamber provided with a series of guides at its side walls, the guides being arranged one above another in pairs, of slidable supports for articles mounted one above another in the guides, each support comprising a series of frames arranged end to end in abutment with each other.

Tunnel kiln. THOMAS TALBOT. U. S. 1,804,657, May 12, 1931 In a tunnel kiln comprising a heating zone and a cooling zone with a goods passageway therethrough, the improvement which comprises a fluid channel adjacent the goods passageway in one portion of the cooling zone, a second cooling zone portion between the first-mentioned portion and the heating zone, and means for circulating a cooling medium through the channel in the first-mentioned portion at a pressure below atmospheric and delivering the medium to the second-mentioned portion at a pressure above atmospheric.

Ceramic kiln. JEGOR I. BROWN. Ger. 513,581, July 28, 1926. An electrically heated tunnel kiln for firing ceramic ware at high temperatures with preheating, firing, and cooling zones is described. (*C.A.*)

Habla's kiln. RUDOLF HABLA. Czechoslo. 30,556; *Stavivo*, p. 231 (1930).—Habla Brothers from Toužím (near Karlovy Vary-Carlsbad) have invented a cheap construction of round kiln. Only the circumferential and middle walls are erected. The firing

chambers are made of green brick. The smoke flues are arranged on the outside and driers are provided thereon. R.B.

Carbonization oven. MAX. KIESEWETTER. Ger. 504,497; *Gas Age-Rec.*, **67** [18], 703 (1931).—This shaft type oven is provided with a carbonizing drum or cylinder hung in the oven proper. The carbonizing drum is made in the form of a cone, the apex of which is at the lower end of the apparatus. E.J.V.

Regenerative coke oven. COLLIN & CO. AND J. SCHAEFER. Ger. 496,810; *Gas Age-Rec.*, **67** [18], 703 (1931).—The arrangement of regenerators in this coke oven is one of its features. One set is located along the length of the battery of ovens while another set is arranged across the width of the battery. The regenerators are associated with all or a part of the heating wall. A special connection between the heating walls and the regenerators is provided. E.J.V.

Making a high calorific value gas from low-grade fuels. BRAUNKOHLEN UND BRIKETT IND. A.-G. AND WOLDEMAR ALLNER. Ger. 504,021; *Gas Age-Rec.*, **67** [18], 703 (1931).—This process is concerned with the production of gas, which can be used for all purposes in the domestic and industrial fields, from bituminous fuels, particularly low-grade fuels. E.J.V.

Gas generator. HERMANN SOEHTZ. Ger. 503,749; *Gas Age-Rec.*, **67** [18], 703 (1931).—This generator is featured by a movable grate with an ash-removing device. The grate is built up of a number of disks or units arranged one above the other and supported centrally by being fixed to a central pipe or tube. E.J.V.

Geology

Collinsics of minerals. I. H. COLLINS. *Chem. News*, **142** [3700], 162–65 (1931).—Data are given on twelve minerals containing zirconium. **II.** *Ibid.*, **142** [3706], 257–61 (1931).—The collinsics of 19 minerals are given. A collinsic is an exact mathematical deduction upon all experimental data concerning a substance, forming an entirely new and exact method of research. G.R.S.

Action of carbon dioxide under pressure on salts of alkaline earth metals. I. Action on calcium phosphates. ERNST MÜLLER AND JULIUS KNÖFEL. *Z. anorg. allgem. Chem.*, **194** [2], 258–60 (1930).—Carbon dioxide under 60 atmospheres was allowed to act on secondary and tertiary phosphates of calcium. The solubility was then determined. The amount of P_2O_5 and of CaO decreased with increasing temperature in the case of secondary phosphates; this is probably due to the following reactions: (1) $2CaHPO_4 + H_2CO_3 = Ca(H_2PO_4)_2 + CaCO_3$ (2) $CaCO_3 + H_2CO_3 = Ca(HCO_3)_2$. Such behavior is expected since the p_H of CO_2 solutions is increased by pressure. The action on artificial phosphates is not as pronounced, possibly due to the more dense structure of such phosphates. **II. Action on alkaline earth silicates.** ERNST MÜLLER AND WALTER LUBBERGER. *Z. anorg. allgem. Chem.*, **194** [2], 261–67 (1930).—Calcium, barium, and strontium monosilicates were used in these studies. The pressure of the carbon dioxide was 50 atmospheres. The solubility of those materials in CO_2 water decreased with increasing temperature. Free SiO_2 was never found in solution. In order to show that free SiO_2 was not present as absorbed on the excess silicate, however, attempts were made to determine it by displacing the equilibrium by combining such SiO_2 with some other material. $Al(OH)_3$ was used with any free SiO_2 which would combine and precipitate. When $Al(OH)_3$ was added to the solutions no changes in the solubility relations could be detected; hence it was concluded that no free SiO_2 existed in their solutions. On decreasing the pressure of the CO_2, the solubility of the silicates decreased. L.T.B.

Absorption of a crystal of dialogite. PIERRE LEROUX. *Compt. rend.*, **189**, 162–63 (1929).—Repeating work previously done on the pleochroism of tourmaline, dialogite

is shown to have greater absorption perpendicular to the optic axis than parallel to it and this difference becomes greater in passing from violet to red light. R.H.E.

Economics of nonmetallic mineral industries. III. Summary of factors in valuation of deposits. RAYMOND B. LADOO. *Rock Prod.*, **34** [9], 44–45 (1931).—L. discusses prospecting and sampling, elements of value in a deposit, present market value of the material, and the fair return on a rock products investment. For Part II see *Ceram. Abs.*, **10** [6], 456 (1931). W.W.M.

Carbon and sulphur content of Ohio common clays in heavy-ware industries. G. M. MACHWART AND J. R. WITHROW. *Ind. Eng. Chem.*, **22** [11], 1224–25 (1930).—The sulphur and carbon contents of 27 Ohio clays have not previously been reported. The methods used and results obtained are described. R.G.M.

Bentonite in ceramic bodies. H. T. COSS. *Ceram. Age*, **17** [3], 147–49 (1931).—Methods of testing are described. Bentonite gives (1) increased plasticity, (2) tender drying, (3) discoloration in white ware, (4) increased dry strength, (5) increased shrinkage, (6) lower vitrification point, (7) lower P.C.E., and (8) decreased density. Bentonite finds a wide use in the field of heat insulation. A table illustrating the results obtained from additions of bentonite up to 4% to a refractory body is included. Previous work and patents are cited. R.G.M.

Clearing turbidity of clays. F. FOERSTER. *Kolloid-Z.*, **52**, 160–63 (1930); *Tonind.-Ztg.*, **54** [82], 1313 (1930).—F. cites one of his explanations (*Chem. & Ind.*, **28**, 24 (1905)) on the troublesome action of uncombined lime in the liquefaction of clays. It was shown that $Ca(OH)_2$ has a strong flocculating action on clay suspensions. In this new work, F. determines that the action can be detected up to a concentration of $^1/_{200}$ *N* $Ca(OH)_2$. With smaller concentrations the peptizing action of the hydroxyl ions introduced with calcium hydroxide counteracts the precipitating action of calcium ions. If calcium sulphate solutions are used the peptization by hydroxyl ions is avoided and thus the action of calcium ions can be carried on up to a concentration of $^1/_{3000}$ *N*. Calcium hydroxide clarifies quicker than the equally concentrated calcium sulphate solution. The technical advantages and disadvantages of using calcium hydroxide or calcium sulphate are discussed briefly. M.V.K.

Sodium: production of natural compounds. ANON. *Chemicals*, **35** [17], 6 (1931).—A detailed report with chart for the past ten years shows the production of natural compounds of sodium and also boron minerals in the U.S. G.R.S.

Southern chemical industries development. L. B. HITCHCOCK. *Chem. Met. Eng.*, **38** [3], 150 (1931).—A brief discussion is given of the importance of chemical industries in the South. Statistics are given in three tables in which clay products are included. G.R.S.

Bauxite in Arkansas. ANON. *Chemicals*, **35** [10], 6 (1931).—A brief report is given of bauxite production in the U.S. Arkansas produces 95% of the American bauxite. G.R.S.

Geological aspects of coal formation. C. S. FOX. *Fuel Sci. Prac.*, **9** [12], 548–59 (1930). R.G.M.

Canadian nonmetallic mineral products. ANON. *Chem. News*, **142** [3703], 214 (1931).—A brief account is given of the amounts and value of nonmetallic mineral products made in Canada for 1929. See also *Ceram. Abs.*, **10** [5], 396 (1931). G.R.S.

Canadian feldspar and lime. ANON. *Chem. News*, **142** [3705], 251 (1931).—Canadian feldspar has a high potash content, uniform quality, and freedom from foreign minerals. Limestone contains about 3% impurities. G.R.S.

Canada's feldspar production. ANON. *Pottery Gaz.*, **56** [647], 716 (1931).—The production in Canada, imports, and exports of feldspar in 1929 and 1930 are presented and compared. E.J.V.

Canadian whiting substitutes. ANON. *Chem. News*, **142** [3700], 168 (1931).—Finely pulverized limestone came into prominence during the World War and is being produced in large amounts. G.R.S.

British china-clay industry in 1930. A. B. COOKE. *Commerce Repts.*, No. 19, pp. 345–46 (1931).—During 1930 the china-clay production declined about 15% from 1929, due in a large measure to the 17% decrease in exports. The exports to the U.S. declined 27%, due partly to the substitution of cheaper American clays as a consequence of the depression. The outlook is not encouraging. E.J.V.

1930 Nova Scotia Mines report. ANON. *Clay Prod. News*, **4** [4], 5–13 (1931).—The annual report of the Nova Scotia Mines shows a production of 18,075,948 brick, 845,186 partition tile, 160,460 drain tile, 9576 sewer pipe, and 700,094 interlocking tile. There were also produced 17,006 T. of dolomite, 2344 T. of fire clay, 7928 T. of silica, and 154 T. crude and 170 T. calcined diatomaceous earth. See also *Ceram. Abs.*, **10** [5], 396 (1931). W.C.O.W.

Genesis of Japanese acid clay. K. KOBAYASHI AND K. YAMAMOTO. *Chem. News*, **142** [3697], 116 (1931).—The formation of acid clay is attributed to the decomposition of soda feldspar and sodium silicate which is interdeposited between pretertiary strata and liparite. The decomposition proceeds markedly through up-gushing gases. See also *Ceram. Abs.*, **10** [5], 391 (1931). G.R.S.

Diatomite in French North Africa. ANON. *Refrac. Jour.*, **7** [4], 230 (1931).—At Cantal there is a lignite concession with a small output sold for domestic purposes, but it produces a large quantity of lignite schists which are converted into kieselguhr, an infusorial earth. E.P.R.

BOOKS

Geologic Structures. BAILEY AND ROBIN WILLIS. McGraw-Hill Book Co. *Pit & Quarry*, **22** [2], 83 (1931).—The book describes geologic structures and their interpretation. Sedimentary, igneous, and metamorphic processes and the mechanics of rock deformation are explained. The book comprises four sections with nineteen chapters. E.P.R.

Systematic Crystallography. T. V. BARKER. xi + 115 pp., 2 plates. Thomas Murby, London, 1931. Price 7s 6d. Reviewed in *Times Lit. Supp.*, **30**, 83 (1931).—The classification and identification of crystals by a simple process of measurement, geometrical analysis, and reference to tables are presented. H.H.S.

Handbook of Cornish Geology. E. H. DAVISON. 2nd ed. 115 pp. Oscar Blackford, Truro, 1931. Reviewed in *Times Lit. Supp.*, **30**, 119 (1931). H.H.S.

Chemistry and Physics

Some physico-chemical properties of clays. I. Base exchange or ionic exchange. G. WIEGNER. *Chem. & Ind.*, **50** [8], 65–71 (1931).—W. discusses (1) the results of Way's researches and the viewpoint of his contemporaries, (2) formation of substances in the colloidal state by weathering, (3) ionic exchange with varying silica and aluminium content, (4) structure of the exchanging micelle, (5) ionic exchange in the outer layer of the micelle, (6) influence of ionic exchange on the water content and viscosity, (7) dehydration of ions, (8) pore size of permutites and clays, (9) difference between clay and kaolin during exchange, and (10) total absorption of hydroxides. **II. Hydrogen clay.** *Ibid.*, **50** [13], 103–12 (1931).—(1) Hydrogen exchanges into an ultramicron easily but out from it with great difficulty. (2) Particles or micellae containing a preponderance of hydrogen ions increase the hydrogen-ion concentration of a dispersion medium by

being suspended in it. (3) The acid dispersion can be shown for different systems both by electrometric and by inversometric measurements. (4) The dispersion medium after the removal of the suspended particles has a constant hydrogen-ion concentration, independent of how many particles were in it. (5) The introduction of particles containing a preponderance of active hydroxyl ions increases the alkalinity of a dispersion medium. (6) The transition from the acid to the alkaline suspension effect has been observed in the same suspension. (7) The apparent increase of the hydrogen- or hydroxyl-ion concentration is proportional to the number of particles in the suspension. (8) The acid suspension effect is quantitatively the same whether measured electrically or inversometrically, as long as the ultramicron is solid. (9) Ionic exchange experiments have thrown much light on the constitution of the micelle. G.R.S.

Expansion relations of some ceramic bodies. WILLI M. COHN. *Keram. Rund.*, **38**, 275–79, 329–32, 360–64 (1930).—Thermal expansion measurements on ceramic bodies up to 1000°C were made in an apparatus in which the expansion of the test piece (a bar) relative to that of fused silica was expressed by the tilting of a mirror mounted on the furnace and the deflection of a beam of light reflected therefrom. The combination of the deflection expressing length change and the deflection from a galvanometer showing temperature change was registered on a photographic plate giving directly the curve of length change with temperature. Some of the results for ceramic materials, in most cases prefired, were as follows: (1) Zettlitz kaolin, fired to cone 1a (1100°), shows uniform expansion except for a slight discontinuity at 300°C noted previously in clay bodies and also found in this investigation in Berlin and Haldenwanger porcelain, "Pythagoras" body, and in many fired refractory clay bodies. (2) Earthenware, stoneware, and porcelains, in addition to the breaks for cristobalite and quartz when these were present, showed an unexplained break at about 800° also observed by other workers. (3) Expansion curves on silica-rich refractory materials fired at different temperatures show the decrease in the break due to the quartz inversion and the increase due to the cristobalite inversion with increase in the temperature of firing. (4) Alumina-rich refractories, including mullite, show only small discontinuities, one being at about 300°. (5) Thermal expansion curves for artificial corundum, corundum-clay and corundum-talc mixtures, and silicon carbide are also given. See also *Ceram. Abs.*, 10 [5], 368 (1931). H.I.

Tendency of microscopic particles to adhere to walls of the same nature. I and II. A. v. BUZAGH. *Kolloid-Z.*, **51**, 105–11, 230–39 (1930).—Suspensions of powdered-quartz particles were flowed into a small glass tube equipped with removable transparent plane parallel windows. The number of particles of different sizes settled on the lower window per unit area was determined microscopically. The tube was rotated so that the lower window was uppermost and the particles still adhering were counted. The ratio of the number adhering to the number originally settled on the window represented the adhesion tendency. It was shown that for quartz windows there is a relation between adhesion tendency and particle size. The adhesion tendency must be considered as a surface function. Both Brownian movement and the force of gravity act to diminish adhesion. Particles above and below a limited range of sizes tend to drop off the surface. In distilled water and with quartz windows quartz particles of 3 microns diameter show the greatest adherence. The adherence power between quartz grains and quartz windows in water reaches a value of about 0.3 dynes/sq. cm. For the smallest particles the longer they remain in contact with the surface, the greater their adhesive power. This is attributed to the presence of a solvate shell of considerable size around each particle. To investigate the relation between adhesion power and zeta potential (cataphoresis migration velocity), suspensions of quartz powder in the various electrolytes were used and reversible electrodes were introduced into the glass tube. In general, no

marked parallelism was shown but there was some relation when ions in small concentration acted as dischargers in the presence of bivalent alkaline earth ions and in small concentrations of aluminium and thorium ions. In gelatin solutions the adhesion tendency of a quartz suspension passes through a minimum with increasing gelatin concentrations. H.I.

Bulking properties of microscopic particles. P. S. ROLLER. *Ind. Eng. Chem.*, **22** [11], 1206–1208 (1930).—By means of an air analyzer for fine powders, anhydrite, gypsum, Portland cement, and chrome-yellow powders were separated into homogeneous fractions above 1 micron in surface mean diameter. The bulkiness, or volume per unit weight, was found to increase with decrease in particle size below a critical diameter; for particle sizes above the critical diameter, the bulkiness was constant. For all powders the same functional relationship was found to hold between the voids per gram and the surface mean diameter. The differences in the value of the constant for the different powders appear to depend chiefly on the particle shape, whether cubic, prismatic, basal, etc. As would be expected from a consideration of packing small particles in the voids of larger particles, the surface mean diameters of the Portland cement and chrome-yellow microscopic powders calculated from the bulkiness of the powder were found to average several tenths of a micron higher than the true mean diameters. With this correction in mind, for powders above one micron surface mean diameter, a rapid method presents itself of estimating the mean particle size of the microscopic powder from a knowledge of its curve of bulkiness vs. particle diameter, but no knowledge of the distribution of particle sizes in the powder is thus obtained. See also *Ceram. Abs.*, **10** [6], 458 (1931). R.G.M.

Microscopic examination of colloidal powders in polarized light. A. MICHEL-LEVY AND H. MURAOUR. *Compt. rend.*, **189,** 1192–93 (1929).—Contrary to statements of previous writers, the authors find examination of colloidal powders under polarized light practicable and of much value in determining structures. They have applied it in explaining certain discrepancies in the chemical behavior of colloidal nitrocellulose. R.H.E.

Microstructure of some porcelain glazes. CLYDE L. THOMPSON. *Ceram. Ind.*, **16** [5], 542 (1931); for abstract see *Ceram. Abs.*, **10** [6], 463 (1931). W.W.M.

Influence of salts on acid solubility of kaolin. TARO TANAKA. *Keram. Rund.*, **38,** 373–77 (1930).—A pure kaolin, either alone or mixed with known amounts of $CaCl_2$, $MgCl_2$, $BaCl_2$, or NaCl, was heated in a platinum resistance furnace at 650°C for periods of $^1/_2$ hr. and 3 hr. The weight loss and the amounts of SiO_2 and Al_2O_3 dissolved after shaking in contact with HCl for 8 hr. in a thermostat at 25°C were determined. It was found that (1) the solubility of the kaolin increases rapidly with increasing amounts of $CaCl_2$; (2) at 650°C a slow double decomposition of the kaolin and the $CaCl_2$ takes place; (3) the molecular ratio of the dissolved SiO_2 to Al_2O_3 increases with additions of the salts mentioned up to 1.1; (4) $CaSiO_3$ does not occur in noticeable amounts in kaolin heated with $CaCl_2$; (5) the solubility is small with additions of $BaCl_2$; (6) most SiO_2 is dissolved when NaCl is the salt added and most Al_2O_3 and $Al_2O_3 + SiO_3$ when $MgCl_2$ is the salt added; and (7) there is a marked increase in the weight loss on heating when $MgCl_2$ is added. H.I.

Dehydration and rehydration of kaolin. P. SCHACHTSCHABEL. *Chem. Erde*, **4,** 395–419 (1930).—Kaolin after being heated at 400 to 800° is capable of taking up H_2O again. This is effected very slowly at 110° but under pressure at 175 to 205° all is restored after 100 hr. The rehydrated kaolin differs from the original material by being partly soluble in HCl, in its dehydration curve, n, and X-ray pattern, but these differences become less marked after prolonged heating of the material in H_2O at 200°. (*C.A.*)

Kaolin suspensions in various media.* RENÉ DUBRISAY, JEAN TRILLAT, AND ASTIER. *Compt. rend.*, **189**, 41–43 (1929). R.H.E.

Determining carbon dioxide in carbonates. C. A. JACOBSON AND J. W. HAUGHT. *Ind. Eng. Chem.* [Anal. Ed.], **2** [3], 334–35 (1930); *Rock Prod.*, **33** [20], 63–64 (1930).—An apparatus is described, modifications of present methods are suggested, and a table showing per cent of error is included. Illustrated. R.G.M.

Determination of potassium in silicates. ANON. *Glashütte*, **61**, 55 (1931).—The difficulty of determining the potassium in glasses, glazes, enamels, and their raw materials is pointed out, and an account of six suitable methods is given.

(*Trans. Ceram. Soc.* [Eng.])

Structure of silicates. W. L. BRAGG. *Glastech. Ber.*, **8** [8], 449–53 (1930); *Diamant*, **52** [19], 305–306 (1930); see also *Ceram. Abs.*, **10** [4], 303 (1931). E.J.V.

Rapid method for determination of selenium. E. BENESCH AND E. ERDHEIM. *Chem. Ztg.*, **54**, 954 (1930); *Analyst*, **56**, 133 (1931).—A large excess (30 g.) of hydrazine hydrochloride is added to the solution of Se in HCl. The solution is boiled for 30 minutes, in which time the Se changes from the red to the black variety. The precipitate is dried at 110°C and weighed. H.H.S.

Analysis of fluorine as calcium fluoride. E. CARRIÈRE AND ROUANET. *Compt. rend.*, **189**, 1281–82 (1929).—Contrary to usual practice, the precipitation with CaC_2l is carried out in alkaline solution, the precipitate washed several times, dried, and weighed as CaF_2. As small excess of $CaCl_2$ as possible is used to cut down the washing. The determination may be made volumetrically by precipitation with a known quantity of $CaCl_2$, then after removal of the precipitate, precipitation of the excess Ca^{++} as CaC_2O_4, dissolution in H_2SO_4, and titration with standard $KMNO_4$. See also *Ceram. Abs.*, **9** [10], 882 (1930). R.H.E.

Equilibrium between potassium, sodium, and their iodides in the molten state. E. RINCK. *Compt. rend.*, **189**, 1272–74 (1929).—By heating mixtures of KI and Na or of K and NaI to 800°C in a sealed steel tube, the equilibrium constant of $Na+KI \rightleftharpoons NaI + K$ is found to be 56. It is noted that the constants of the iodide, bromide, and chloride systems are in nearly exact proportions to their atomic weights. See also *Ceram. Abs.*, **9** [11], 978 (1930). R.H.E.

Decomposition of sodium carbonate by heat. J. T. HOWARTH AND W. E. S. TURNER. *Jour. Soc. Glass Tech.*, **14** [56], 394–401 (1930).—Attention was given to the decomposition of sodium carbonate as measured by the pressure of the resulting CO_2 in a closed vessel. When heated in air no loss resulted till a temperature of 800°C was attained. At 1000°C white fumes appeared. The dissociation pressure obtained from a straight-line graph should reach a value of 760 mm. at 1750°C. G.R.S.

Direct determination of sodium in the presence of aluminum and chromium. E. R. CALEY AND D. V. SICKMAN. *Jour. Amer. Chem. Soc.*, **52** [11], 4247–51 (1930).—The authors show that the direct magnesium uranyl acetate method for sodium is applicable in the presence of aluminum and chromium. The undesirability of having a high concentration of ammonium salts when making direct sodium determinations in sulphate solution is pointed out. R.G.M.

Note on electrometric titration. S. R. SCHOLES. *Glass Ind.*, **12** [5], 112 (1931).—A slight change made by lengthening the tube carrying the platinum electrode used in making an electrometric determination of acid-soluble iron in glass sand which resulted in greater accuracy of the method is described. Illustrated. E.J.V.

Zinc oxides by French process. ANON. *Ceram. Ind.*, **16** [5], 472 (1931).—Ana-

* Please note year number which was published incorrectly in *Ceram. Abs.*, **9** [6], 471 (1930).

conda zinc oxides are manufactured by the French process, in which the pure zinc metal is heated in muffle furnaces to a temperature above its boiling point and the zinc vapor is burned to zinc oxide. W.W.M.

Hyrax, new mounting medium for diatoms. G. DALLAS HANNA. *Jour. Roy. Microscopical Soc.*, **50**, 424–26 (1930).—Hyrax is a synthetic resin, a derivative of naphthalene, which has been prepared by Penn & Ruedrich (Associated, Calif.) so that it has only a pale straw color. It is soluble in benzene and xylene but not in alcohol or water. The solvent is easily expelled with gentle heat and does not tend to produce bubbles to such an extent as does the volatile constituents of Canada balsam. After hardening, Hyrax will withstand a high temperature without discoloration. Index of refraction of the hardened material is 1.82. When hot the resin is very fluid. No decomposition or discoloration has been noted in the slides after $3^1/_2$ years except when exposed to direct sunlight for long periods. H.I.

Suggested method for determining plasticity of clays. E. J. C. BOWMAKER. *Jour. Soc. Glass Tech.*, **14** [56], 330–48 (1930); for abstract see *Ceram. Abs.*, **10** [2], 148 (1931). G.R.S.

Determination of crystallite by means of X-rays. L. GREBE. *Z. tech. Physik*, **11**, 428–29 (1930); *Chem. Zentr.*, ii, 3175 (1930).—Debye lines are obtained with the specimen and with a pure comparison substance and the intensities are compared. The intensity is proportional to the crystallite content and not to the particle size. The method is applied to quartz in clay, etc. (*B.C.A.*)

Method of finding the refractive index of a drop of mounting medium. D. S. SPENCE. *Jour. Roy. Microscopical Soc.*, **49**, 224–28 (1929).—The material whose index is to be measured is melted or dropped into a spherical hollow ground into one surface of an object slide of known index of refraction. This is covered with a second object slide (excluding bubbles) of the same index of refraction. The whole is placed in the substage of a microscope, other lenses in the condenser system being removed. The refractive index of the medium, $n_1 = n_2 + r/f$, where n_2 is the index of refraction of the object slide, r is the radius of curvature of the hollow, and f is the focal length of the system. The focal length may be measured by finding the distance between the images (using the system above described) of two distant objects, one being on the optical axis, which subtend a convenient known angle at the point of observation, and dividing the length thus found by the tangent of the angle. H.I.

High-temperature equilibrium of titanium dioxide and carbon with titanium carbide and carbon monoxide. L. R. BRANTLEY AND A. O. BECKMAN. *Jour. Amer. Chem. Soc.*, **52** [10], 3956–62 (1930). R.G.M.

Studies on thermochemistry of compounds occurring in the system CaO–Al_2O_3–SiO_2. IV. Heat of solution of tricalcium aluminate and its hydrates in hydrochloric acid. T. THORVALDSON, W. G. BROWN, AND C. R. PEAKER. *Jour. Amer. Chem. Soc.*, **52** [10], 3927–36 (1930); for Part III see *Ceram. Abs.*, **9** [9], 783 (1930). R.G.M.

Relation between grain size and interstitial space in products of unconsolidated granules. A. H. M. ANDREASEN AND J. ANDERSEN. *Kolloid-Z.*, **50**, 217–28 (1930).—Theoretical considerations show that in the production of an unconsolidated material of unoriented grains in which the percentage of interstitial space is to be held constant with the addition of larger and larger grain sizes, the distribution of grain sizes must satisfy the equation, $C(k) = k^q$. For products with the same granulation figures (distribution of grain sizes) the interstitial space increased with the quantity, q. Investigation of products of two and three grain sizes were made for comparison with the directions of Grün and of Kerkhof for obtaining the densest possible materials. Finally, products with values for q of ∞, 2, 1, $^2/_3$, $^1/_2$, and $^1/_3$ together with one according to the "Fuller curve" were made and their interstitial spaces compared. It was shown that greater

density can hardly be expected from products built up of a few selected grain sizes than from those in which all grain sizes within certain limits are present. H.I.

Coagulation. G. WIEGNER. *Chem. & Ind.*, **50** [7], 55–62 (1931).—Until recently all coagulation investigations dealt exclusively with spherical particles, but lately the importance of needle-shaped particles has been recognized. Particles of clay appear flat rather than spherical. Rapid perikinetic coagulation of monodisperse and polydisperse systems is discussed in detail. Seventeen tables of data are included. Slow coagulation of clay suspensions and coagulation of oppositely-charged colloids are treated. The dependence of coagulation on electrical potential is illustrated with experiments on quartz suspensions. G.R.S.

Volumetric determination of tin. S. G. CLARKE. *Analyst*, **56**, 82–89 (1931).—Sn is reduced from the stannic condition by metallic lead and titrated with iodine in the presence of lead. Cu and Sb interfere. H.H.S.

Electrolytic separation of lead and antimony. E. M. COLLIN AND H. J. S. SAND. *Analyst*, **56**, 90–93 (1931).—Sb is first oxidized to antimonate by iodine in the presence of bicarbonate. Tartaric acid is added and the solution made strongly alkaline with KOH. Pb is then deposited as metal by an external current or by internal electrolysis with zinc anodes. H.H.S.

Colorimetric determination of phosphoric acid in soils. R. G. WARREN AND A. J. PUGH. *Jour. Agric. Sci.*, **20**, 532–40 (1930); *Analyst*, **56**, 128 (1931).—A solution of aminonaphthol sulphonic acid in $NaHSO_3$ solution is used to estimate the phosphate in HCl or citric acid extracts of soils, a standard solution of KH_2PO_4 being used as comparison. Fe should first be removed by ferrocyanide, ammonium molybdate added, and then the coloring agent. H.H.S.

New reagent for copper: direct green-B. P. SISLEY AND DAVID. *Bull. soc. chim.*, No. 47–48, pp. 1188–92 (1930); *Analyst*, **56**, 132 (1931).—Direct green-B (No. 593 Color Index, Allen's Organic Analysis) changes to violet-rose with Cu. H.H.S.

New source of nitrates. ANON. *Glass Ind.*, **12** [5], 115 (1931).—A new source of nitrate of soda is found in the air-nitrogen plant at Hopewell, Va. E.J.V.

Sodium sulphate and other mineral salts of British Columbia. C. W. AUSTIN. *Mining Ind. Rec.*, **34** [5], 61–63 (1931).—A brief account is given of the occurrence, development, and analyses of the deposits of sodium sulphate and sodium carbonate in British Columbia. Data on commercial production of these salts are presented and their uses are discussed. E.J.V.

Art of metallography. FRANCIS F. LUCAS. *Mining & Met.*, **12** [293], 12–14 (1931).—The fundamentals of metallographic research are discussed. L. describes the working of the microscope, the testing, correcting, and cleaning of objectives, and the new Zeiss metallurgical equipment. E.J.V.

Slide comparator. W. A. TAYLOR & CO. *Can. Chem. Met.*, **15** [4], 112 (1931).—A new set for p_H control work is described, supplied to cover the p_H range 0.2 to 13.6, each comparator covering a range of 1.6 p_H units. Illustrated. E.J.V.

BOOKS

Optical Activity and High Temperature Measurements. F. M. JAEGER. McGraw-Hill Publishing Co., Ltd., London. Price 20s net. Reviewed in *Engineering*, **131** [3404], 475 (1931).—This volume, in the main, is the reprint in book form of the series of lectures delivered by J. of the Univ. of Gröningen at Cornell Univ. during 1928–1929. The first section deals with spatial arrangement of atomic systems and optical activity. In the second section a survey is made of methods of precise measurement at high temperatures as they have been developed during the last twenty years at the Univ. of Gröningen. A.A.

Qualitative Chemical Analysis. HERMAN T. BRISCOE. D. Van Nostrand Co. New York. Price $2.25. Reviewed in *Can. Chem. Met.*, **15** [4], 54 (1931). E.J.V.

Lunge and Keane's Technical Methods of Chemical Analysis. 2nd ed. Vol. 3. Edited by C. A. KEANE AND P. C. L. THORNE. 678 pp. Gurney & Jackson, Edinburgh, 1931. Reviewed in *Chem. News*, **142** [3704], 238 (1931). G.R.S.

Textbook of Inorganic Chemistry. Vol. VII, Part II. Sulphur, Selenium, and Tellurium. R. H. VALLANCE, D. F. TWISS, AND A. R. RUSSELL. Edited by J. Newton Friend. 420 pp. Charles Griffin & Co., London, 1931. Reviewed in *Chem. News*, **142** [3703], 222 (1931). G.R.S.

Practical Microchemistry. (German.) F. EMICH. 2nd ed. J. F. Bergmann, Munich, 1931. xii + 157 pp., 83 illus. Price 12.80 Rm. Reviewed in *Analyst*, **56**, 138–39 (1931).—The book contains an additional chapter by F. Feigl on "spot" methods. H.H.S.

Annual Tables of Constants and Numerical Data. Index, Vols. 1–5. Compiled by G. KRAVTZOFF. Reviewed in *Chem. News*, **142** [3698], 142 (1931); for abstract see *Ceram. Abs.*, **10** [5], 392 (1931). G.R.S.

General

Behavior of various clays with crude and reclaimed rubber. H. A. WINKELMANN AND E. G. CROAKMAN. *Ind. Eng. Chem.*, **22** [8], 865–69 (1930).—The maximum and minimum variations produced by a large number of commercial clays in crude and reclaimed rubber were determined in both uncured and cured products. Chemical analysis gives little information on variation in plasticity, retentivity, and softness in crude acid reclaimed rubber. Microscopic examination of clays is more informing. R.G.M.

Notes on clay and fired clay products. G. S. STAIRS. *Eng. Jour.*, **13**, 688–93 (1930).—Some of the properties of clay as a material and the methods of manufacture of such clays which are of importance to structural engineers are indicated. The manufacture of brick and of structural tile is outlined. Advantages and disadvantages of the car tunnel and the downdraft kilns are listed. A flow sheet of manufacturing processes in the clay-product industry and a brief discussion are included. (*C.A.*)

Some less familiar applications of soluble silicates. JAMES G. VAIL. *Ind. Eng. Chem.*, **22** [9], 972–74 (1930). for abstract see *Ceram. Abs.*, **10** [1], 67 (1931). R.G.M.

Producing higher steam pressures and temperatures. C. F. HIRSHFELD. *Eng. & Finance*, **22** [2], 49–50 (1930). R.G.M.

Combustion control. ANON. *Elec. Rev.*, **108** [2783], 537–38 (1931).—Advocates of automatic combustion control have emphasized the claims for advantages in connection with pulverized-fuel firing in meeting exigencies pertaining to the use of low-grade fuel. Automatic boiler control equipment is simple and thus has a high reliability factor. E.P.R.

Slag wool as heat insulator. H. BOHLANDER. *Internat. Bull. Refrigeration*, **11**, 562 (1930).—Pressed slag wool contains 90% air and is a good insulator. To prevent disintegration it is mixed with $MgCO_3$ for packing. See also *Ceram. Abs.*, **10** [1], 77 (1931). H.H.S.

Basis for retiring equipment. R. L. CAPSON. *Chem. Met. Eng.*, **38** [4], 202–203 (1931).—A discussion is given of the criteria that may be used for comparing the present

equipment with the proposed new model. Examples are used to illustrate the applications of principles discussed. G.R.S.

Equipment economics. L. S. ABBOTT. *Chem. Met. Eng.*, **38** [4], 204–205 (1931).—An analysis is shown of the various items of cost of manufacture. G.R.S.

Trend of wages and employment. ANON. *Factory & Ind. Management*, **81** [5], 818 (1931). E.C.C.

Carew tower, Cincinnati, Ohio. ANON. *Arch. & Bldg.*, **58** [2], 34 (1931).—In finishing both the Carew Tower and the hotel with its arcade approach and patio, an extensive use was made of fine metal work, tile marble, and glass. In the patio, there are two panels of Rookwood tile. In the hotel, glass in the form of gold- and silver-plated mirrors is used extensively in the finishing of the gallery, ballroom, crystal room, and foyer. Ornamental black glass is also advantageously used. Polished plate glass is used for all windows and tapestry glass is used in office doors. Polished wire glass finds an important use. In plumbing fixtures there is an interesting use of color, both in vitreous china and colored enameled iron. E.P.R.

Building as means for business recovery. C. S. TAYLOR. *Ceram. Age*, **17** [2], 90–92 (1931).—T. presents forecasts and graphical data pertaining to the building industry. R.G.M.

Building plants. HARRY E. STITT. *Chem. Met. Eng.*, **38** [4], 196–99 (1931).—Valuable tables are shown giving a comparison of simple and multistory buildings and approximate cost of various forms of floor, wall, and roof constructions. G.R.S.

The Government in ceramics. ANON. *Ceram. Age*, **17** [3], 129–67 (1931).—This report describes investigations in progress or just completed at the U. S. Bureau of Standards. R.G.M.

Donald E. Sharp. F. W. PRESTON. *Glass Ind.*, **12** [5], 111 (1931).—A brief biographical sketch of the vice-chairman of the Glass Division of the AMERICAN CERAMIC SOCIETY is presented. Illustrated. E.J.V.

Federation of interests. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **10** [5], 119–20 (1931).—A plea is made for the federation of the interests of the various trade associations now in existence for each distinct type of product in the ceramic industries. E.J.V.

Coöperation with trade and technical bodies. THOMAS B. FORD. *Clay-Worker*, **95** [4], 262–64 (1931).—F. points out the value and possibilities of coöperation in the field work of the Structural Clay Tile Assn., citing specific examples as references to back up his arguments. E.J.V.

Economic conditions of 1930. V. V. KELSEY. *Ceram. Age*, **17** [1], 15–16 (1931). R.G.M.

Everyday ceramics. ANON. *Nat. Glass Budget*, **46** [51], 20 (1931); for abstract see *Ceram. Abs.*, **10** [5], 396 (1931). E.P.R.

Ceramics in a pasteboard building. ANON. *Ceram. Age*, **17** [4], 203–205 (1931).—The representation of the ceramic industries in the Century of Progress Exposition in Chicago is discussed. R.G.M.

Ceramic exhibit at University of Illinois engineering open house. ANON. *Clay-Worker*, **95** [4], 253 (1931).—The extensive display of ceramic raw materials, processes, and products is described. E.J.V.

Rutgers University ceramic exposition. ANON. *Clay-Worker*, **95** [4], 248–50 (1931); see also *Ceram. Abs.*, **10** [6], 467 (1931). E.J.V.

British Empire trade exhibition at Buenos Aires. ANON. *Pottery Gaz.*, **56** [647], 698–702 (1931).—A description of the pottery and glassware exhibits at the Buenos Aires exhibition is given. Illustrated. E.J.V.

Exhibition of British glassware. ANON. *Pottery Gaz.*, **56** [647], 691–97 (1931).—

A description is given of the exhibition held in Selfridge's store in London to illustrate the variety of goods for which the glass industry is responsible. This exhibition is an outcome of the Glass Convention. Illustrated. E.J.V.

International Exhibition, Liège, 1930. R. BARTA. *Stavivo*, p. 387 (1930).—Brick, refractory products, fine ceramics, glass, etc., were exhibited by Czechoslovakian, Polish, Japanese, Italian, Spanish, and Egyptian schools. Illustrated. R.B.

Pottery and glassware at the Swedish Industrial Art Exhibition. ANON. *Pottery Gaz.*, **56** [647], 703–706 (1931).—Some of the exhibits of Swedish pottery and glassware on display at the exhibition held in London, March 17 to April 22, 1931, under the sponsorship of the Swedish Government and the Anglo-Swedish Society, are described. Illustrated. E.J.V.

Report of the Glass Research Delegacy. ANON. *Jour. Soc. Glass Tech.*, **14** [56], 307–13 (1930).—The 14th Annual Report of the Delegacy shows the progress made in glass technology. G.R.S.

German pottery industry. ANON. *Pottery Gaz.*, **56** [647], 697 (1931).—A brief review of the 1930 business in the German pottery industry is presented, with comparisons with other years. E.J.V.

Study tour and German-English convention. G. GEHLHOFF. *Glastech. Ber.*, **8** [6], 321–29 (1930); for abstract see *Ceram. Abs.*, **9** [10], 891 (1930). E.J.V.

Ceramic industry of Canada. NATIONAL DEVELOPMENT BUREAU. *Can. Chem. Met.*, **15** [3], 33 (1931); *Pottery Gaz.*, **56** [646], 570–72 (1931); *Clay Prod. News*, **4** [4], 3 (1931); for abstract see *Ceram. Abs.*, **10** [6], 467 (1931). E.J.V.

Chinese potteries. KARL VICK. *Keram. Rund.*, **38**, 267–69 (1930). H.I.

Junior technical school at Stoke. ANON. *Times Eng. Supp.*, **27**, 486 (1931).—A school for special training of children for industry, especially branches of the pottery trade, is to be established in Stoke-on-Trent. H.H.S.

State Ceramic School in Bechyně. A. STAŠEK. *Trans. Czechoslo. Ceram. Soc.*, No. 1 (1931).—This school was founded in 1884. In the surroundings of the commune Bechyně there are alluviations of tertiary clay. In recent years the school has taken part in many international exhibitions, *e.g.*, Monza 1923, Paris 1925, Barcelona 1929, etc. The ceramists who attend this school are occupied in practice not only in Czechoslovakia, but also in France, Belgium, Italy, Jugoslavia, Bulgaria, Germany, Russia, etc. R.B.

Reform of professional instruction in ceramic schools in Czechoslovakia. R. BARTA. *Stavivo*, p. 333 (1930); *Trans. Czechoslo. Ceram. Soc.*, No. 1–2 (1930).—B. recommends the reform and complete reorganization of professional instruction at ceramic schools, especially to accommodate the plan of instruction to the needs of the country. Proposals worked out by the committee of the Czechoslo. Ceram. Soc. are mentioned. R.B.

Report on the activity of the State Silicate Research Institute at Brno. O. KALLAUNER. *Stavivo*, p. 32 (1930).—In 1929 nine specialists worked at the Institute. Eighteen scientific works and 72 studies were published. R.B.

Wisconsin Clay Products Manufacturers hold interesting meeting. ANON. *Clay-Worker*, **95** [4], 265 (1931).—A brief report of the April meeting, with short summaries of papers presented, is given. E.J.V.

Society of Glass Technology, March meeting. ANON. *Nat. Glass Budget*, **47** [2], 17 (1931).—Abstracts of the two papers presented are given: (*a*)" Some Notes on the Manufacture and Performance of Slip Cast Tank Blocks," by P. Haller. (*b*) "Studies of Clay Mixtures for Glass Melting Pots, Parts I and II," by J. H. Partridge and G. F. Adams. E.P.R.

Society of Glass Technology, April meeting. ANON. *Pottery Gaz.*, **56** [647], 687–90 (1931).—A report of the annual general meeting held on April 15, 1931, is presented. E.J.V.

BOOKS

Dictionary of the World's Commercial Products. J. H. VANSTONE. Sir Isaac Pitman & Sons, London. *Refrac. Jour.*, **7** [4], 245 (1931).—Materials of interest to ceramists which have separate sections are brick, bath brick, bauxite, black lead, bole, bone earth, boracic acid, borax, cement, chalk, clay, coal, faience, fire clay, fullers' earth, glass, granite, kaolin, lime, limestone, ocher, plumbago, porcelain, pottery, quartz, silicon carbide, and ultramarine. A valuable feature is the French, German, and Spanish terms for each substance mentioned. E.P.R.

World Minerals and World Politics. C. K. LEITH. Univ. of Wis., McGraw-Hill Book Co. ANON. *Pit & Quarry*, **22** [2], 83 (1931).—In this volume, L. discusses the relation of nations and continents to the productive reserve supplies and possible future developments of mineral resources, and analyzes the political significance of these factors. E.P.R.

Effects of Asbestos Dust on the Lungs and Dust Suppression in the Asbestos Industry. E. R. A. MEREWETHER AND C. W. PRICE. H. M. Stationery Office. Price 1s 3d net. Reviewed in *Engineering*, **129**, 577 (1930).—The dust formed in the treatment of asbestos produces effects which are generally similar to those arising from the silica-laden dust. The fibrous formations are not exactly the same and they appear to develop more rapidly, though adding less to the patient's susceptibility to phthisis. Asbestosis has also been added to silicosis as an occupational disease arising from working in dusty surroundings. A.A.

Manual of Mining Economics. (Lehrbuch der Bergwirtschaft.) K. KEGEL. Verlag von Julius Springer, Berlin. 653 pp. Price 48 Rm. Reviewed in *Colliery Guard.*, **142** [3667], 1301 (1931).—This excellent work indicates a remarkable development in mining technique. The book is divided into eight sections, the character of each being discussed. E.J.V.

Modern Brickmaking. ALFRED B. SEARLE. *Refrac. Jour.*, **7** [4], 245 (1931); for abstract see *Ceram. Abs.*, **10** [6], 429 (1931). E.P.R.

Hydraulic classification for fine sand sizing. HUGH HADDOW, JR. 11 pp., 8 illustrations. Bur. Mines, *Information Circ.*, No. 6420 (1931).—H. describes methods of recovery and treatment of sand and gravel at the Menantico Sand & Gravel Co., Millville, N. J. R.A.H.

Book Review

The Art of Pottery. IRMA GALL AND VIVIAN VAN ETTA. Bruce Publishing Co., Milwaukee, Wis. 80 pp. Price $1.35. Eighteen full-page plates and twenty-one illustrations in the text comprising designs, drawings, and photographs. Frontispiece in colors. This book presents a series of fourteen problems in pottery making which the authors have developed and successfully used as a course of elementary instruction for junior high school students.

Its chief value to teachers lies in the well-organized "work sheets" by which each problem is presented. Necessary materials and tools, steps in the process, and references to helpful literature are set down in a simple but detailed fashion. A professional potter might criticize the text for certain technical inaccuracies and inadequacies, but in spite of its title, the book does not pretend to be a treatise on the potter's art. As an organized plan for introducing the subject to young students, it will be helpful to many art teachers in the public schools and will, no doubt, find a wide usefulness. A.E.BAGGS

Better Business

Larger Profits

More Versatile Production

Energetic Surveys of Production and Market Possibilities

These Topics Are Indicative of the Purposes of the

34th Annual Meeting

of the

American Ceramic Society

WASHINGTON, D. C.

FEBRUARY 7 to 12 inclusive, 1932

COLOR UNIFORMITY

Factory and Laboratory controlled colors, under the constant watch of a staff of experienced color experts, gives you the assurance of reliability.

Every shipment is carefully checked to match identically every previous lot. You will appreciate this factor resulting in the elimination of unnecessary grief.

●

Known for their strength, purity and uniformity, "Hommel" Colors are recognized as "Standard" for the Ceramic Industry.

COMPLETE LINE
of
CERAMIC COLORS AND CHEMICALS

THE O. HOMMEL CO., INC.
209 4th Ave., Pittsburgh, Pa.

A Coöperative Enterprise

Purchasing adverti ing space in this Journal is reciprocity with those on whom you depend for sale of your product.

This Journal is published by the industrial, technical ceramists who make the decisions regarding materials and equipment to be used. It is not issued for financial profit and the sale of advertising space meets only a portion of the cost of publishing.

Here is your opportunity to help yourself by assisting your customers!

The Zirconium Oxide Opacifier

FOR WALL TILE AND TERRA COTTA

During 1930 and 1931 when sales curves for almost everything have been sloping downward, the use of Opax in Tile and Terra Cotta glazes has been increasing rapidly from month to month. Today more pounds of Opax are going into these products than ever before.

Whiteware Ceramic Engineers tell us that no other opacifier approximates Opax in value. This stands for both bright and matte glazes. Opax gives most pleasing texture to matte finishes and a surface that is most easily cleaned.

In color glazes, Opax holds the tone. All agree that colors are erratic and variable with other opacifiers. Decorative Opax over-glazes do not blur into the background glaze even when this is of darker color.

Effects such as these produced by Opax are greatly influencing the buyers of your product. Get them with Opax. It is economical to use and does not vary in price.

The Titanium Alloy Manufacturing Company

Manufacturers of chemicals and enamel frit.

Ceramic Materials Division

1204 Keith Building, Cleveland, O.

BULLETIN

of the

AMERICAN CERAMIC SOCIETY

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions, and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

WALTER P. SUTER, MYRTLE M. FRENCH	Art	A. E. R. WESTMAN, DOROTHY A. TEXTER	Refractories	HOWELLS FRÉCHETTE, AMOS P. POTTS	Structural Clay Products
BRYAN A. RICE, W. N. HARRISON	Enamel	E. H. FRITZ, H. M. KRAMER	White Wares	L. E. RIDDLE, V. V. KELSEY	Materials and Equipment
G. W. MOREY, LOIS PURDY TURNER	Glass	H. G. SCHURECHT, GAIL R. TRUMAN	Terra Cotta		

OFFICERS OF THE SOCIETY

E. V. ESKESEN, President
10 E. 40th St., New York, N. Y.
ALEXANDER SILVERMAN, Vice-President
University of Pittsburgh, Pittsburgh, Pa.
H. B. HENDERSON, Treasurer
Standard Pyrometic Cone Co., Columbus, Ohio
ROSS C. PURDY, General Secretary and Editor
EMILY C. VAN SCHOICK, Assistant Editor
2525 N. High St., Columbus, Ohio

TRUSTEES

EDWARD ORTON, JR.
GEORGE A. BOLE
C. L. SEBRING
E. P. POSTE
C. D. SPENCER
J. M. McKINLEY
H. C. KLEYMEYER
D. F. ALBERY
EDWARD SCHRAMM
V. V. KELSEY

Vol. 10 **July, 1931** **No. 7**

EDITORIALS

SCHOOL TRAINING

Schools are provided and the law requires that boys and girls shall attend school until they have attained the age at which they normally would complete their high school education. Systematic school training is also provided for those who are physically and mentally handicapped. Systematized training is compulsory for the young and for those who are handicapped.

For those who have reached the age or are judged to have discretion, systematic schooling is optional. Presumably one undertakes collegiate training of his own free will and for a definite purpose. He accepts the judgment, based on experience, that collegiate training will enable him to obtain a more certain and a more profitable participation in human affairs.

Completion of a course of study is an accomplishment and an attainment, in recognition of which the school issues a diploma. A collegiate degree is in recognition of studies successfully pursued through recitations and examinations. Diplomas and degrees are not certificates and awards for successful application of the knowledge or of aptitude in human affairs.

J. B. Ward in a recent number of *Chemistry and Industry* aptly asked whether the function of a university training is merely that of systematic acquiring of facts or is it, in part, the acquisition of a profitable attitude in human relations (known as culture).

Ward says, "Surely the latter is dependent on the former. Some minds provided with facts become cultured; others, on the same pabulum, merely encyclopedic. In short, to produce the cultured man, knowledge must react with an inner potentiality. Can any training whatsoever create that potentiality?"

Obviously, the answer is that schools can merely give training in the acquisition of facts; the potentiality to use the facts must be inborn.

Several persons are successfully engaged in industrial ceramics who have not had the advantage of a collegiate training. This is their handicap. That they have made good in spite of this handicap is evidence of an inborn potentiality to obtain and to marshall facts for specific applications. Colleges and especially the state universities would be placing recognition where recognition is deserved if they would grant degrees to those who have gained prominence for proficiency in the use of facts without requiring that the facts used be acquired through collegiate instruction.

State universities are granting "engineering degrees" to those of their graduates who have been graduated for a term of years and who will present a written thesis. There is no uniformity in stressing how successfully the candidate has used his collegiate training in the five or more years since obtaining his academic degree. There is uniformity, however, in stressing the importance of a written thesis. Universities seem willing at times to waive lack of accomplishment, but stand staunchly for a thesis.

Recognition of culture (ability to use facts profitably in human affairs) is of far greater importance than recognition of scholastic ability to record facts. This applies to organizations like this SOCIETY as well as to schools.

Theses, reports of investigations, and records of observations have a large value, first, as means of establishing records on which to base advancements in art, science, and technology, and second, as the author's means of making an exact survey of the facts known and to be obtained for the solution of the problem reported.

Written reports are evidence of the author's ability to make systematic application of facts and to analyze the results obtained. They do not reveal, however, the broadness of the author's interests or the scope of his abilities.

Thesis reports are indicative but they fall far short as a measure of the author's inborn potentiality to create new applications of facts or to respond readily to industrial problems. In brief, they do not reveal fully his aptitude and adaptability in industrial employment.

Collegiate training is a positive aid to cultural attainments and industrial success. The handicap of not having had this training is becoming greater with each yearly acquisition of recorded knowledge. The greater facilities which college training gives one to find and to apply information is responsible for the displacement of the "practical" by the "college" men. But for a college man to succeed, he must have that inborn potentiality to acquire and to use facts; a human quality often spoken of as common sense and judgment by which many practical men, without the advantages of college training, have been so highly successful.

Let us honor those who have succeeded and do this without reference to the course of training by which they have developed their potentialities for success or by what evidence they show their abilities. There are Edisons, Fords, and Lindberghs engaged in ceramic manufacturing. Our editorial hat is off in honor of Mike Owens, Dressler, and many others who have achieved success in ceramics and especially do we honor those who cannot write theses but give aid unstintingly to the advancement of this SOCIETY and to other organized efforts to advance ceramic art, science, and technology.

OHIO IS HONORED BY A FEW OF HER EARLY GRADUATES

Edward Orton, Albert Bleininger, Carl Harrop, Wilber Stout, Frank Riddle, Arthur F. Greaves-Walker, Joseph Shaw, and John Martin received the degree of Ceramic Engineer at the Ohio State University, June, 1931, commencement convocation. These were men qualified (1) by having practiced five years or more as ceramic engineers, (2) by presenting theses, and (3) by paying $10 diploma fees. Their application for this degree was duly considered and granted not because of their prominence in ceramics or because of their world-known attainments, but because as Ohio State graduates they made application and they qualified.

Any Ohio State graduate of five years' standing who can spare $10 and who can write an acceptable thesis is elegible for this Engineer's Degree in ceramics regardless of how successful he might be as a practising ceramist.

Ohio State University was honored when these eight prominent ceramists applied. Ohio State University would be honored if a few more of her graduates of notable record would apply. Neither honor nor recognition was conferred on these men; just the reverse. They were honoring their Alma Mater and each other.

A red-blooded he-man ordinarily will not "apply" for recognition. He

will let his works demand it. In the case of this class of eight notables there were good and sufficient reasons why they consented to apply. They applied for the degree together as evidence of personal friendship. They conformed to rules of "application," for in no other way could they honor one another and honor their Alma Mater.

But it was a notable event in ceramics when these eight joined the ranks of the Ceramic Engineer Degree men of Ohio. Arthur Watts, Robert Montgomery, and Wolsey Worcester took their "application" in previous years.

The universities would be doing a fine thing for themselves if they would confer this Engineer's Degree in recognition of attainments and of services rather than on application by the graduate. Too much emphasis is placed on theses and not enough on attainments. The intended honor is nullified by insistence on the candidate making application and thus making the "honor" (?) available to many who for "their works" are not known.

PAPERS AND DISCUSSIONS

1930 PROGRESS REPORT OF THE REFRACTORIES DIVISION[1] RESEARCH COMMITTEE[2]

The present progress report consists of three separate contributions, all of which are designed to encourage and coördinate research on refractories. They are as follows:

I. Researches on Refractories That Are at Present in Progress

As old researches are continually being completed or abandoned and new ones started, no attempt has been made to have this list complete. An effort has been made by this Committee, however, not to publish information which the donors do not want published.

A. V. Henry, Georgia School of Technology, Atlanta, Ga.

(1) Fundamental properties of Georgia kaolin and bauxites at various high temperatures and variation in original (raw) structure, such as pit lumps and dobies.

This work is to consist of a series of studies covering several years, showing the value of Georgia clays for refractories.

The present work is a study of grog grading on the properties of kaolin refractories.

Paul E. Cox, Iowa State College, Ames, Iowa.

(1) Not carrying on any refractories research work at present but have equipment for such research.

F. H. Norton, Massachusetts Institute of Technology, Cambridge, Mass.

(1) Further development of high temperature insulated refractories.
(2) Design of furnace constructed with insulating refractories.
(3) Petrographic studies of slags and glasses.

S. M. Phelps, Mellon Institute, Pittsburgh, Pa.

(1) Size variation of fire brick and shapes.
(2) Rapid method for estimating the alumina content of diaspores.
(3) The effects produced on refractories by various atmospheres at elevated temperatures.
(4) The development of low-temperature bonding cements without the use of sodium silicate.
(5) The removal of pyrite from plastic clays.
(6) The development of a suitable spalling procedure for use with the service spalling furnace.

M. E. Holmes, Missouri School of Mines and Metallurgy, University of Missouri, Rolla, Mo.

(1) Adjustment of P.C.E. test method to high temperature cements that contain added fluxes. This study is being carried on in connection with Committee C 8, A.S.T.M.
(2) Study of the methods of determining P.C.E. value below cone 20. This study is being carried on in connection with Committee C 8, A.S.T.M.
(3) Studies of dry-press process:
    (*a*) Effect of grain size on pressure transmission.
    (*b*) Effect of air evacuation.
    (*c*) Effect of mix wetness, forming pressure, time of pressure application, and shape of grain on transmission of pressure.
    (*d*) Miscellaneous problems on dry press, die lubrication, and bentonite admixture.
(4) A study being started of the volume changes which Missouri refractory materials

[1] Received May 27, 1931.

[2] The 1929 Progress Report of this Committee is to be found in *Bull. Amer. Ceram. Soc.*, **13**, [5], (Part 1), 158 (1930).

undergo on heat treatment, such as secondary expansion and lengthening of the vitrification range by adding silica and other materials.
(5) Lesser studies on diaspore and chrome refractories.

E. H. Wells, New Mexico School of Mines, Sorarro, New Mexico.

(1) Activities of the State Bureau of Mines and Mineral Resources are at present confined almost entirely to the study of the geology and mineral resources of the State.

Chas. F. Binns, New York State College of Ceramics, Alfred University, Alfred, N. Y.

(1) The relation of time and temperature to the rate of inversion to cristobalite and tridymite of eight American quartzites.

R. M. King, Ohio State University, Columbus, Ohio.

(1) Effects of composition, method of forming, and firing temperature of checker brick on their physical properties.
(2) Resurvey of Lawrence County clays.

A. E. R. Westman, Ontario Research Foundation, 47 Queen's Park, Toronto 5, Canada.

(1) Equilibrium moisture content and drying shrinkage of plastic ceramic mixtures under mechanical pressure and in contact with water at atmospheric pressure. The rate at which equilibrium is obtained.
(2) Rapid methods for determining the moisture content of ceramic mixtures.

J. B. Shaw, Pennsylvania State College, State College, Pa.

(1) Abrasion of refractories at high temperatures. Chisel test in comparison with other abrasion tests.
(2) Possible fire clays of anthracite region in the neighborhood of Scranton, Pa.

G. H. Brown, Rutgers University, New Brunswick, N. J.

(1) Unusual refractory materials as refractories.
(2) Refractory heat-insulating cements.

W. F. Dietrich, Stanford University, Dept. of Mining Engineering, Stanford University, Calif.

(1) Investigation of clays and ceramic mixes, using a modified form of the Talwalkar-Parmelee apparatus.
(2) Equipment for testing refractories and for preliminary development of firebrick mixtures.

T. N. McVay, University of Alabama, University, Alabama.

(1) Development of a refractory insulating material.

Merle Randall, University of California, Department of Chemistry, Berkeley, Calif.

(1) On account of the wide range of problems which the chemistry student of the Pacific Coast may have to tackle, this department is primarily interested in teaching fundamentals.

R. K. Hursh, University of Illinois, Urbana, Ill.

(1) Slagging of boiler-furnace refractories.
(2) Study of the properties of spinels. A series of spinels, representing aluminates, ferrites, and chromites, have been prepared. Specific gravity, optical properties, specific heat, and coefficient of expansion are being determined by ordinary methods.

John D. Clark, University of New Mexico, Department of Chemistry, Albuquerque, New Mexico.

(1) Interested in the subject, but doing no active work on refractories at present.

W. G. Worcester, University of Saskatchewan, Ceramic Engineering Dept., Saskatoon, Saskatchewan, Canada.

(1) Study on the reversible expansion of fire brick under repeated heatings, the heatings being carried to approximately 1350°C.

(2) Collection of fire-box temperatures of oil-burning locomotives under active working conditions. A thermocouple is placed in the direct flame at the forward end of the fire box.
(3) A spalling research on fire brick made in western Canada. These are being compared with Missouri brick and some eastern fire brick.

R. J. Montgomery, University of Toronto, School of Engineering, Toronto, Canada.

(1) A study of refractory bodies used in electric stove heater plates.

R. J. Montgomery, University of Toronto, Ontario Dept. of Mines, Toronto, Canada.

(1) The commercial value of the refractory clays of northern Ontario including field and laboratory work.

Hewitt Wilson, University of Washington, Seattle, Washington.

(1) Progress report on the testing of refractories for service in the soda-recovery furnaces of the pulp and paper companies.

W. A. Koehler, University of W. Va., Morgantown, W. Va.

(1) A resurvey of the refractory clays of West Virginia.

R. A. Heindl, U. S. Bureau of Standards, Washington, D. C.

(1) An investigation of properties of fireclay brick and the fire clays from which they are prepared.
(2) Linear thermal expansion and contraction of fire clay and special refractories to temperatures as high as 1800°C.
(3) The effect of firing treatment on the thermal expansion of kaolins.
(4) Problems relating to saggers and sagger clays.

T. A. Klinefelter, U. S. Bureau of Standards, Columbus, Ohio.

(1) A study of the thermochemical reaction between boiler-furnace slags and refractories.

J. W. Whittemore, Virginia Polytechnic Institute, Blacksburg, Virginia.

(1) A survey of the coal-measure clays of Virginia.

II. High Temperatures as a Field for Physico-Chemical Instruction

By Robert B. Sosman[1]

There is a noticeable scarcity of men properly trained to do basic research on refractories and similar high-temperature materials, and this scarcity results mainly from the fact that few universities or technical schools give instruction in the chemistry and physics, and particularly the physical chemistry, of substances at high temperatures. Instruction in physical chemistry is almost entirely confined to the region between 0°C and 100°C. The extension of the field of instruction to a much wider range of temperatures, both low and high, is easily defended. Such an extension is logical, sound, feasible, and practical.

(1) It is logical because our ordinary range of experiment between 273°K and 373°K is a purely accidental sample of the wide range of accessible temperatures between about 1°K, where helium is solid, and 4000°K, a temperature at which all substances have become either liquid or gaseous. It is true that this customary working range includes the temperatures which we ordinarily have to maintain in our bodies and in our surroundings in order to live, but our current daily activities are no longer confined to this narrow range, as they were before man became inventive. To obtain a fair picture of the whole of physical chemistry, examples should be drawn, both theoretical and experimental, from temperatures suitably distributed over the entire range available to the laboratory.

[1] United States Steel Corp., Research Laboratory, Kearny, N. J.

(2) The extension is pedagogically sound because of the fundamental principle that instruction should proceed from the simple to the complex. The great complexity of chemical reactions and chemical compounds at atmospheric temperatures is admittedly confusing to the student. It would be an interesting and perhaps fruitful project to work out a course of instruction in the principles of chemistry by starting at the highest temperatures known to us, the temperatures of the hotter stars, and then following the evolution of compounds down to our customary temperatures. In some stars matter is found under conditions where even the outside electrons of the atoms are dissociated off and where only the atomic nuclei remain. With falling temperature successive shells and groups of electrons are added to the nuclei, until temperatures of the order of magnitude of the sun or the electric arc are reached, where atoms are complete except for temporary ionization, but where few compounds are stable and where all substances are in the gaseous form at ordinary pressures. At about this range the simplest chemical compounds begin to be formed and their evolution into more and more complex compounds can be followed with diminishing temperature until the regions are attained where the hydrocarbons and finally the complicated series of organic compounds can become stable.

The evolution of heat capacities, from the purely thermodynamic and statistical conditions at very high temperatures to the condition at lower temperatures where the quantum theory becomes important, is another example of this same progression from the simpler idea to the more difficult.

(3) The teacher of chemistry may object that it will be difficult, if not impossible, to accompany such a course with laboratory experiment and instruction. This might have been true a few decades ago, but the development of high-temperature apparatus in recent years has been so rapid that there is now no lack of easily obtainable facilities for laboratory instruction. The extension of such instruction to high temperatures is, therefore, entirely feasible. Temperatures up to 1000°C are easily obtained with electric furnaces having resistance windings of nickel-chromium-iron alloys. Higher temperatures can be reached with platinum resistance windings, which are not abnormally expensive in comparison with other standard apparatus, especially now that the price of platinum has fallen to less than half of its war-time value. If reducing atmospheres are not objectionable, furnaces that are even less expensive can be obtained using graphite or granular carbon or employing tungsten or molybdenum wire in an atmosphere of hydrogen. Gas-heated furnaces of constantly improving constancy and controllability are being developed year by year. Finally there are several types of vacuum furnace available. One of the convenient modern methods of producing high temperatures is the high-frequency induction method, which attains almost any desired temperature quickly, and which, with the introduction of electron-tube sources for the power, should be controllable with precision. Within five or ten years this type of apparatus, which is now rather expensive because the high cost of development has still to be paid, will become a necessity in every research or instructional laboratory worthy of the name.

Instruments for the accurate measurement of high temperatures are available in considerable variety, *e.g.*, resistance, thermoelectric, optical, and radiation, and apparatus can also be had for the measurement of physical properties and the study of structures, both microscopic and molecular, to at least 1000°C and sometimes higher.

(4) Finally, this extension of the field of physico-chemical instruction is eminently practical. I am not one of those who believe that subjects of instruction in chemistry and physics should be closely related to the demands of industry. Competitive industry is, almost of necessity, short-sighted and tends to exert involuntary pressure in the direction of converting educational institutions into trade schools and research laboratories into experiment stations. On the other hand, the current problems of industry, especially in those branches of manufacture that affect large portions of the population, have to

be kept in view. A department of physical chemistry which drew most of its examples from the chemistry of illinium and rhenium could and would be justly criticized, although it might be teaching under a logical and pedagogically sound system.

The chemistry of high temperatures is becoming an increasingly wide field for industrial processes, as a glance at the history of almost any branch of industry will show. The steady drift toward higher temperatures is shown in such familiar examples as the following: ammonia, formerly a low-temperature by-product, now made from electric-furnace cyanamid or by high-temperature and high-pressure synthetic reactions; nitric acid, formerly niter-distilled, now made by oxidation of ammonia; phosphoric acid and phosphorus, now produced from an electric furnace or a blast furnace; potash from bittern-extracted salts, now supplemented by potash distilled out of cement kilns and blast furnaces for iron; petroleum products, formerly made by low-temperature distillation, now produced by high-temperature cracking; numerous organic compounds, formerly dependent on slow reactions at ordinary temperatures, now speeded up by high temperatures under greatly increased pressure; metallurgical products of many kinds, formerly extracted or purified by wet methods or, at best, handled in fuel-fired furnaces whose possibilities were circumscribed by the combustion characteristics of the fuel, now made in electric furnaces whose temperature is limited only by the materials of construction.

This Research Committee of the Refractories Division is not alone in desiring to see more attention paid to high-temperature physical chemistry. It is not even a pioneer. A few years ago a "Committee on the Physical Chemistry of Steel-Making" was formed by the Iron and Steel Division of the American Institute of Mining and Metallurgical Engineers. One of the tasks undertaken was to induce physical chemists and metallurgists to take a joint interest in such problems, and the Committee has already sponsored several sessions for scientific papers and discussions which have brought physical chemistry for the first time into the ken of the operating superintendent, while at the same time they have introduced the physical chemist to new phenomena which cannot but broaden his grasp of his subject.

The Research Committee would like to foster a similar union of interests in the field of refractories, and respectfully urges upon all departments of physical chemistry the desirability of extending the range of temperatures used for instruction as widely as they find it practicable to go.

III. Elementary High Temperature Experiments on Magnesite

March 1, 1931.

The 1929 Report of the Research Committee of the AMERICAN CERAMIC SOCIETY presented a list of research problems pertaining to refractory materials. Most of these were suitable only for graduate students or for research laboratories.

It has since been suggested that the Committee might be of service to some of the technical schools whose faculties wish to give training in high-temperature studies, by listing problems which can suitably be given to undergraduate students. The following suggested laboratory experiments are intended for this purpose, and are offered merely as illustrations of the type of problems which have for their object:

(1) Giving familiarity with high temperature apparatus and training in the technique of high temperature work.
(2) Imparting knowledge concerning certain specific properties of the materials being studied.

The experiments listed pertain solely to magnesite. Similar lists can be prepared, if it seems desirable, based on other types of refractory materials. The problems here given are intended to bring out data concerning the effects of time and temperature of heating upon the dissociation of magnesium carbonate and upon the formation of the mineral periclase (MgO), the effect of an added oxide, Fe_2O_3, the sintering or bonding together of dead-burned magnesite at high temperature, the microscopic structure of the fired products, and some of the properties of commercial brick.

Series I

Studies of rate of dissociation of magnesite and of formation of periclase.

(1) **Materials** (*a*) Pure white dense magnesite such as that from Greece or California.
(*b*) Coarsely crystalline and somewhat less pure magnesite, such as that from Washington or from Czechoslovakia.

(2) **Procedure** (*a*) Run comparative tests on the two magnesites by heating a constant length of time, *e.g.*, 15 minutes, at 400°C and at each 100° interval above that to 1500°C. After cooling, determine loss in weight and specific gravity, and study the fired samples under the microscope.

(*b*) In paragraph (*a*) the time of heating to the maximum temperature is held constant and the temperature varied. In paragraph (*b*) the temperature should be held constant, and the time of treatment varied. Suggested temperatures are 1000°C, 1250°C, and 1500°C; suggested times, $^1/_4$, $^1/_2$, 1, 2, and 4 hours. Determine loss in weight and specific gravity and examine under the microscope.

(*c*) Certain minerals, especially finely-pulverized hematite, are known to hasten the formation of periclase. Grind samples of the magnesites until all will pass a 65- or 100-mesh hand screen. Mix with 5% 100-mesh ferric oxide, and place weighed quantities in crucibles. Heat as in paragraph (*a*) or (*b*) to a series of temperatures beginning at 1000°C in comparison with magnesite to which the iron oxide has not been added. Make the same determinations as above.

Series II

Study of the bonding of dead-burned magnesite and its volume change at high temperatures.

(1) Make briquets of a convenient size from commercial dead-burned magnesite. A bond of the unfired briquets can be secured by the use of water and an organic bond such as dextrine. After thorough drying, heat the briquets a definite length of time, *e.g.*, 1 hour, at a series of temperatures, beginning at 1000°C and at each 100°C temperature interval up to 1500°C. After cooling, determine modulus of rupture, change in volume, porosity, and specific gravity.

(2) Repeat at 1400°C, varying the time from 1 to 2, 4, and 6 hours, making the same determinations as given under Series II, paragraph (1).

Series III

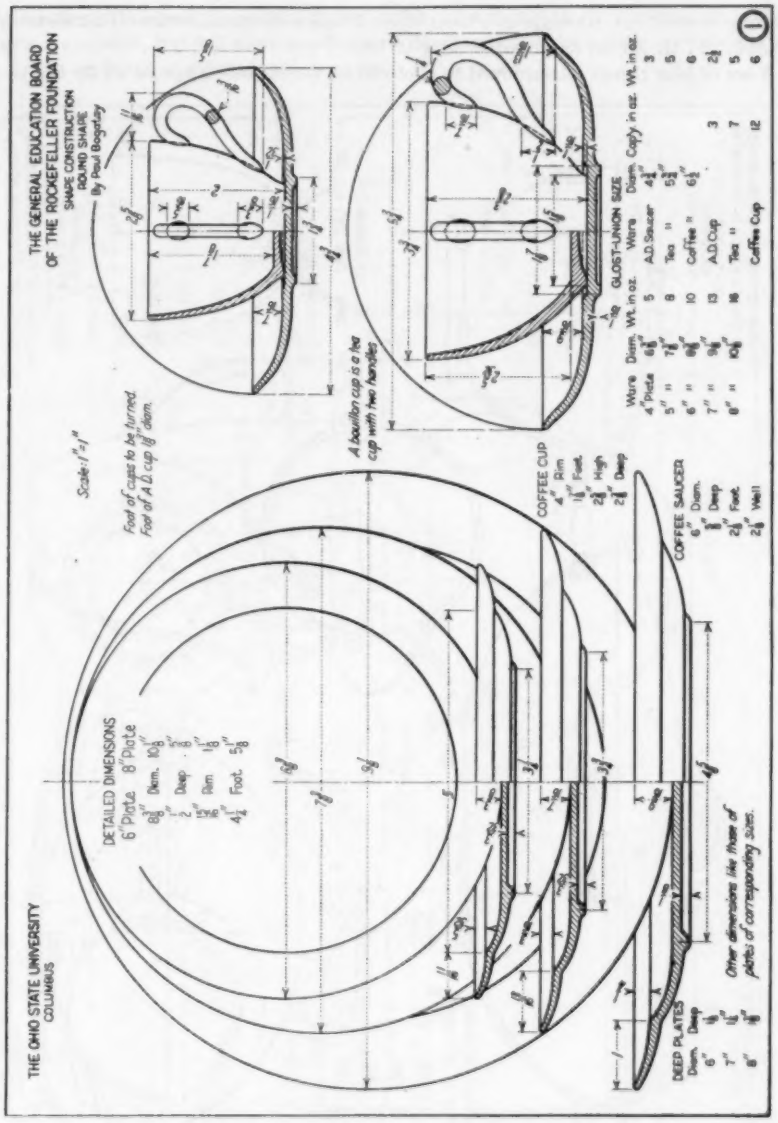
Studies of commercial magnesite brick.

(1) Place a small piece of clay fire brick on one end of a magnesite brick and a small piece of silica brick on the other end. Heat to cones 26 to 30. After cooling, explain any reaction which has occurred by means of microscopic studies.

(2) Repeat, using an acid and a basic slag instead of clay and silica brick. Compare with clay fire brick in an air blast or water-dip spalling test.

The above progress report is respectfully submitted by the Research Committee, Refractories Division.

DONALD W. ROSS, *Chairman*
ROBERT B. SOSMAN
VANCE CARTWRIGHT
R. A. HEINDL
R. A. SHERMAN
L. J. TROSTEL
J. SPOTTS MCDOWELL



SECOND TABLEWARE PROGRESS REPORT

Shape Construction Blue Prints
Round Shape

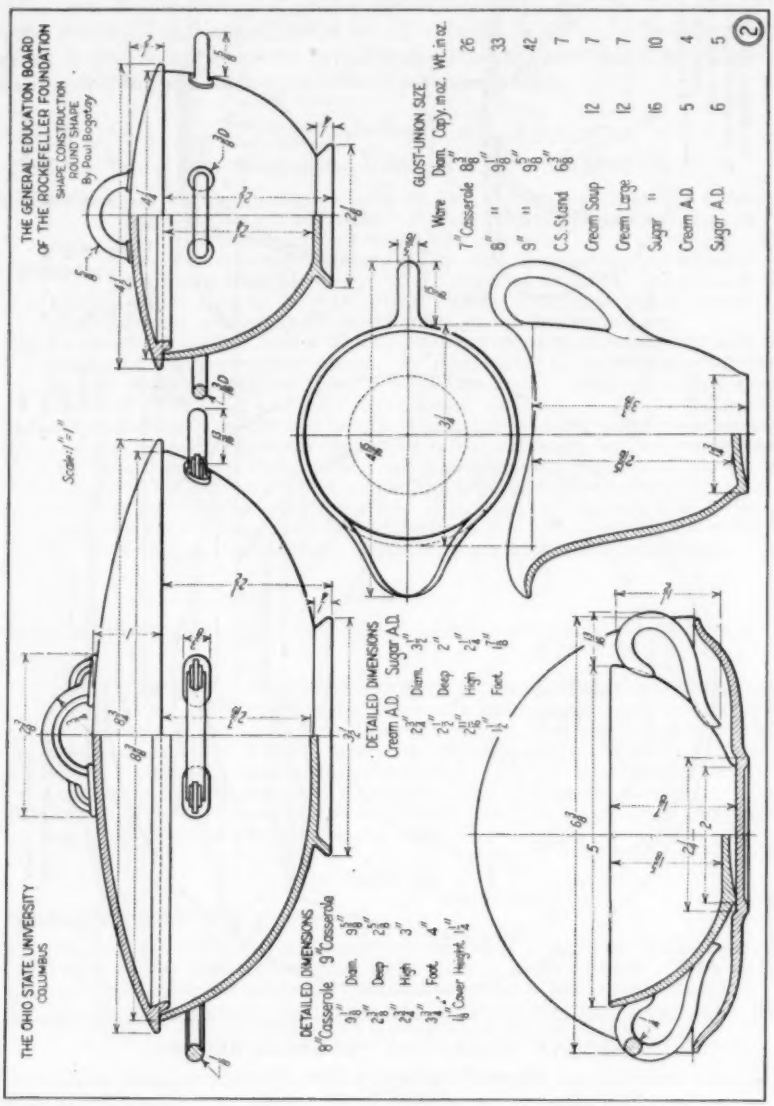
By Paul Bogatay[1]

Detailed technical construction requires blue prints. The development of a new tableware shape is a problem of technical construction. It is, therefore, logical to use

[1] Holder of Fellowship of General Education Board, Rockefeller Foundation, Research in Tableware Design at Ohio State University, Fine Arts College.

carefully worked out drawings as a basis in its design and manufacture. This method is not new. F. H. Rhead discussed it early in 1923.[2]

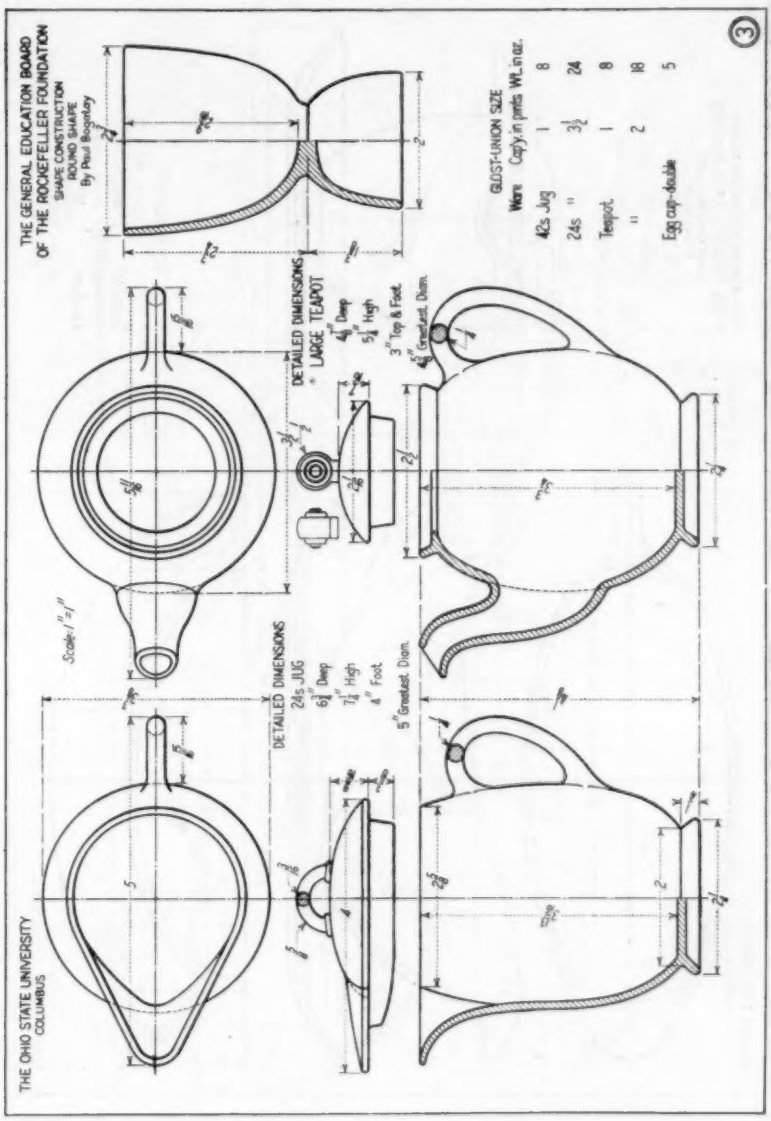
A set of blue prints dimensioned to conform to specifications agreed on by the U. S.



Potters Association and the Brotherhood of Operative Potters is submitted as an example. Their usefulness is naturally limited because no single set of conditions was considered. Technical details were treated broadly and theoretically.

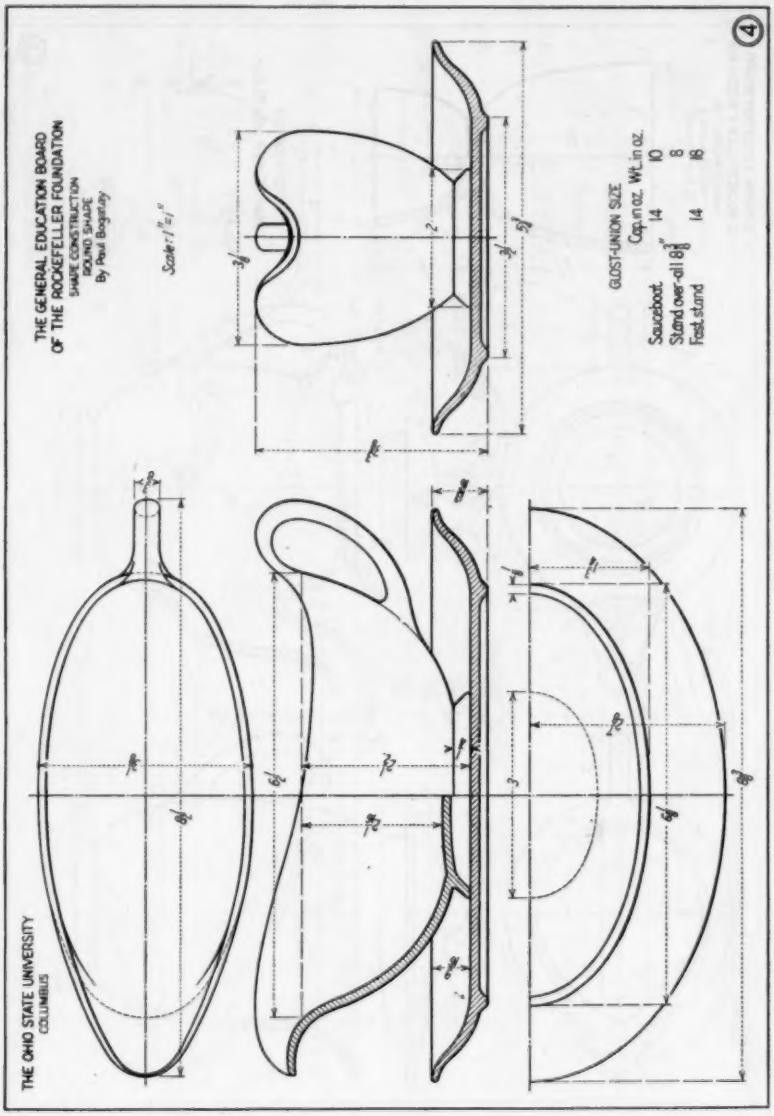
[2] *Bull. Amer. Ceram. Soc.*, **2** [4], 64 (1923).

The attempt has been for simplicity and utility as a means to standardization. The shapes are not ideal, but will serve as a basis for development of new designs by means of blue prints or detailed dimensional drawings.



Drawings would have to conform to the conditions of manufacture, allowing for shrinkage, the drop in the rim of flat ware, the spring necessary in bottoms of both flat and hollow, and all other details controlling production.

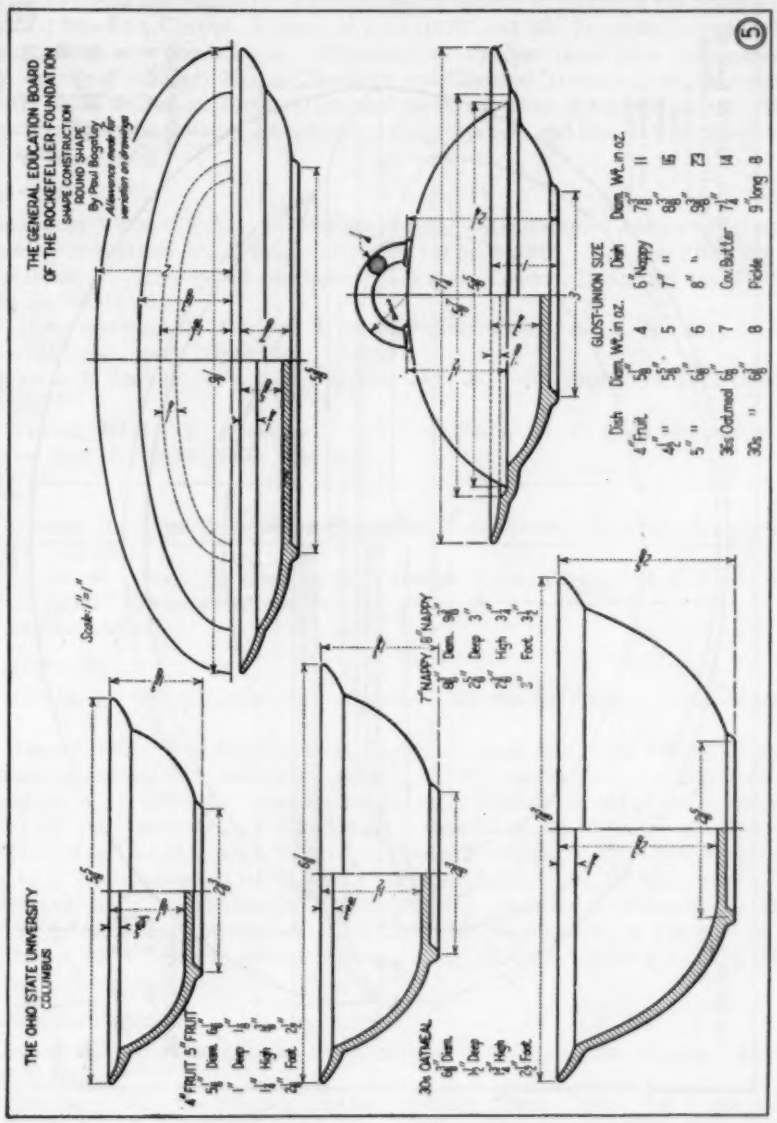
Other than for direct production, the prints may be used in a number of ways; for example, as a basis for new design by tracing the items and making on them the changes



which are required in line, proportion, and decorative detail of the various elements composing the whole. Shapes having entirely different character, but which conform in size, weight, and capacity can be produced. They can be used for checking dimensions

as a basis for discussion of relative costs in merchandizing and production, and other matters requiring reference and consideration.

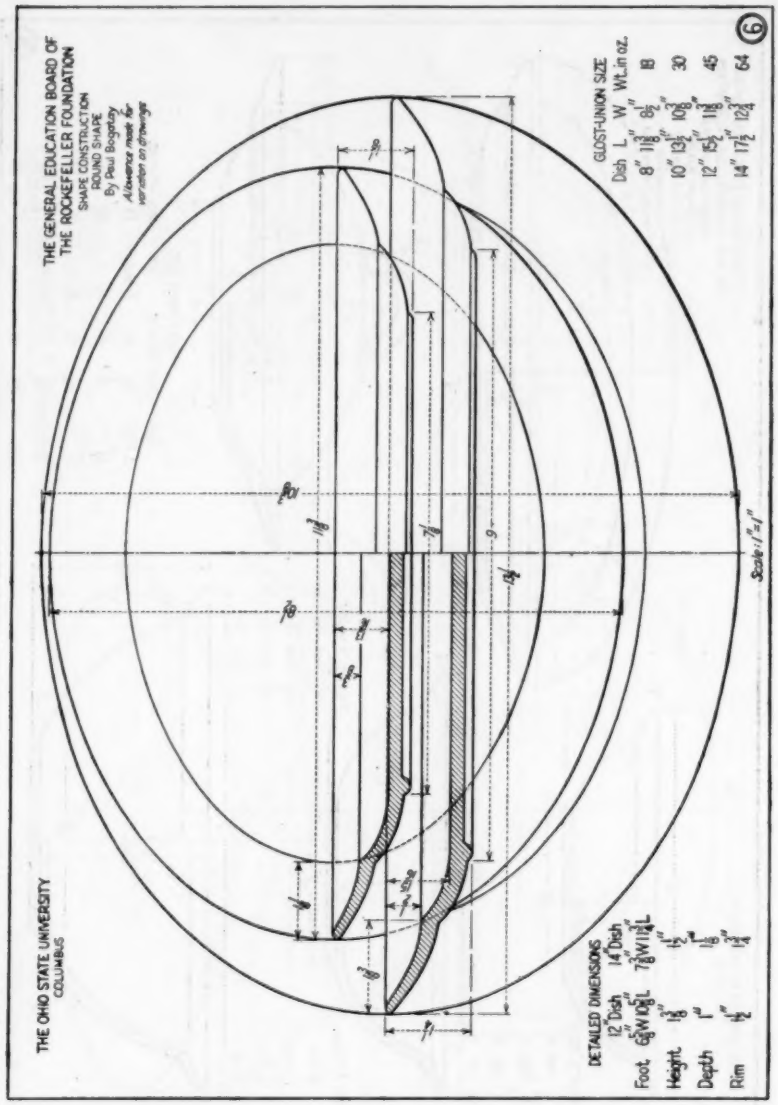
To derive the greatest benefit and use from this project, it is suggested that each plant


THE GENERAL EDUCATION BOARD
OF THE ROCKEFELLER FOUNDATION
SHAPE CONSTRUCTION
ROUND SHAPE
By Paul Bogatay
Allowance made for
variation on drawings
5
GLOST-UNION SIZE
Dish Diam. Wt. in oz. Dish Diam. Wt. in oz.
4" Fruit 5⅛" 4 6" Nappy 7⅛" 11
4½" " 5⅝" 5 7" " 8⅛" 15
5" " 6⅛" 6 8" " 9⅛" 23
36s Oatmeal 6⅛" 7 Cov. Butter 7¼" 14
30s " 6⅞" 8 Pickle 9" long 8
Scale 1/2"
7" NAPPY 6" NAPPY
Diam. 8⅛" Diam. 6⅞"
Deep 3" Deep 2⅝"
High 3½" High 2⅞"
Foot. 3½" Foot. 3"
4" FRUIT 5" FRUIT
Diam. 4⅛" Diam. 5⅛"
Deep 1" Deep 1¼"
High 1⅛" High 1⅜"
Foot. 2⅛" Foot. 2⅝"
30s OATMEAL
Diam. 6⅛"
Deep 1½"
High 1⅝"
Foot. 2⅞"
THE OHIO STATE UNIVERSITY
COLUMBUS

have a set of drawings that conform to that plant's individual set of technical conditions, covering all the details of construction and all the limitations of the particular type of body used, and conforming to the mold size, allowance for shrinkage, drops, springs,

profiles, turning, casting, sticking, etc. The modeler, toolmaker, and clay-shop foreman could then have a definite basis for systematic production.

When the ware shows that mistakes have been made in the first drawings, the



drawings would be an accurate check and reference for filing of tools and changing of profiles. Thus a complete record of changes would be kept that should prove invaluable as a reference record. In time, records on file of problems solved would result in a finer control of details.

BIBLIOGRAPHY OF BIBLIOGRAPHIES

Compiled by Clarence J. West and D. D. Berolzheimer for the National Research Council

The following Bibliography of Bibliographies of interest to ceramists was taken from National Research Council, *Bulletin*, No. 50 (1925) and No. 71 (1929), compiled by Messrs. West and Berolzheimer. Permission to abstract these from their general Bibliography of Bibliographies on Chemistry and Chemical Technology places ceramic readers under obligation to the authors and to the National Research Council. The AMERICAN CERAMIC SOCIETY acknowledges this obligation, and also its appreciation of this work.

Abrasives

EARDLEY-WILMOT, V. L. Artificial Abrasives and Manufactured Abrasive Products. Canada, Dept. Mines, Mines Branch, No. 699, 144 pp. (1929). (Bibl., pp. 109–119.)

HAENIG, A. Emery and the Emery Industry. London, Scott, 103 pp. (1912). (Bibl., p. 103; 14 ref.)

LADOO, RAYMOND B. Garnet. U. S. Bur. Mines, *Rept. of Invest.*, No. 2347, 16 pp. (1922) mimeographed. (Bibl., pp. 15–16; 23 ref.)

LEWIS, J. VOLNEY. Abrasives. *Mineral Ind.*, **28,** 1–10 (1919); **29,** 1–11 (1920). (16 ref.)

MAGNUS, HARRY C. Abrasives of New York State. N. Y. State Museum, *57th Annual Rept.*, **1,** 178–79 (1903). (45 ref.)

Albite

FISCHER, H. Über die optischen Eigenschaften des Albits. *Z. Krist.*, **61,** 226–27 (1925). (24 ref.)

JACOBY, R. Albit. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 3, Pt. 1, pp. 277–78 (1912). (Ref. through text.)

See also Feldspar.

Alkali Metals

HELLER, K. Die Alkalimetalle. *Mikrochem.*, **21,** 182–206 (1930). (Bibl. through text.)

MELLOR, J. W. The Alkalis. *In* Inorg. Theor. Chem., Vol. 2, pp. 421–880 (1922). History, p. 422 (30 ref.); occurrence, p. 427 (50 ref.); preparation, p. 450 (150 ref.), properties, p. 474 (600 ref.); alloys, p. 481 (15 ref.); hydrides, p. 484 (35 ref.); oxides, p. 493 (100 ref.); hydroxides, p. 509 (300 ref.); fluorides, p. 518 (100 ref.); chlorides, p. 555 (800 ref.); bromides, p. 588 (200 ref.); iodides, p. 612 (400 ref.); sulphides, p. 628 (100 ref.); polysulphides, p. 640 (100 ref.); hydrosulphides, p. 645 (25 ref.); sulphates, p. 673 (400 ref.); hydrosulphates, p. 692 (300 ref.); carbonates, occurrence, p. 725 (300 ref.); carbonates, properties, p. 769 (250 ref.); bicarbonates, p. 779 (150 ref.); nitrates, p. 821 (400 ref.); orthophosphates, p. 851 (300 ref.); pyrosulphates, p. 866 (50 ref.); metaphosphates, p. 871 (25 ref.).

Alkaline Earth Metals

BURR, MAY S. The Alkaline Earth Metals. London, Griffin, 346 pp. (1925). (Bibl. footnotes.)

MELLOR, J. W. The Alkaline Earths. *In* Inorg. Theor. Chem., Vol. 3, pp. 619–908 (1923). History, p. 621 (20 ref.); occurrence, p. 625 (60 ref.); preparation, p. 630 (50 ref.); properties, p. 644 (200 ref.); atomic weights, p. 648 (50 ref.); bromides, p. 733 (75 ref.); carbonates, p. 847 (450 ref.); chlorides, p. 723 (400 ref.); fluorides, p. 695 (150 ref.); hydroxides, p. 686 (200 ref.); iodides, p. 740 (75 ref.); nitrates, p. 863 (200

ref.); oxides, p. 652 (250 ref.); phosphates, p. 864 (400 ref.); sulphates, p. 760 (450 ref.) sulphides, p. 740 (200 ref.).

Aluminates

DOELTER, C. Aluminate. *In* Handb. Mineralchem., Vol. 3, Pt. 2, pp. 510–32 (1926). (Bibl. footnotes.)

MELLOR, J. W. Aluminates. *In* Inorg. Theor. Chem., Vol. 5, pp. 298–300 (1924).

Aluminium Oxide

EPHRAIM, FRITZ. Aluminiumoxyd. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 2, Pt. 2, pp. 590–95 (1909). (Ref. through text.)

LEITMEIER, H. Tonerdehydrate. *In* Doelter, Handb. Mineralchem., Vol. 3, Pt. 2, pp. 463–81 (1926). (Bibl. footnotes.)

MELLOR, J. W. Aluminium Oxide. *In* Inorg. Theor. Chem., Vol. 5, pp. 247–72 (1924).

Aluminium Silicates

DOELTER, C. Aluminiumsilicate. *In* Handb. Mineralchem., Vol. 2, Pt. 2, pp. 1–29 (1917). (Bibl. footnotes.)

DOELTER, C. Komplexe Silicate von Aluminium (Eisen) mit einwertigen Alkalimetallen. *In* Handb. Mineralchem., Vol. 2, Pt. 2, pp. 193–208 (1917). (Bibl. footnotes.)

GRÜNER, E. Zur Kenntniss der Ultramarine. *Z. angew. Chem.*, **41**, 446–50 (1928). (31 ref.)

JACOBY, R. Aluminiumsilikate. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 3, Pt. 1, pp. 262–64 (1912). (Ref. through text.)

MELLOR, J. W. The Alkali Aluminium Silicates. *In* Inorg. Theor. Chem., Vol. 6, pp. 594–603, 655–61 (1925). (About 2000 ref.).

MELLOR, J. W. The Alkaline Earth Aluminium Silicates. *In* Inorg. Theor. Chem., Vol. 6, pp. 768–802 (1925). (About 5000 ref.)

MELLOR, J. W. Aluminium Silicates. *In* Inorg. Theor. Chem., Vol. 6, pp. 462–67 (1925). (About 500 ref.)

MELLOR, J. W. Beryllium-Aluminium Silicates. *In* Inorg. Theor. Chem., Vol. 6, pp. 806–808 (1925). (About 150 ref.)

MELLOR, J. W. Hydrated Aluminium Silicates. Clays. *In* Inorg. Theor. Chem., Vol. 6, pp. 500–11 (1925). (About 1500 ref.)

SCHNEIDERHÖHN, H. Über die Umbildung von Tonerdesilikaten unter dem Einfluss von Salzlösungen bei Temperaturen bis 200°. *Neues Jahrb. Mineral. Geol.*, **40**, 163–228 (1915–16). (Bibl. footnotes.)

STREMME, H. Wasserhältige Aluminiumsilicate. *In* Doelter, Handb Mineralchem., Vol. 2, Pt. 2, pp. 30–94 (1917). (Bibl. footnotes.)

Antimony

"Antimony and Compounds." Ind.-Cat. S. G. O., 1st Ser., No. 1, pp. 444–49 (1880); 2nd Ser., No. 1, pp. 537–39 (1896); 3rd Ser., No. 1, pp. 598–99 (1918).

EPHRAIM, F. Antimon. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 3, Pt. 2, pp. 643–851 (1908). (Ref. through text.)

GREAT BRITAIN IMPERIAL MINERAL RESOURCES BUREAU. The Mineral Industry of the British Empire and Foreign Countries. War Period. Antimony. (1913–1919.) London, H.M.S. Off., 34 pp. (1921). (Bibl., pp. 31–34.)

GROSCHUFF, E. Reines Antimon. *Z. anorg. allgem. Chem.*, **103**, 164–88 (1918). (Bibl. footnotes.)

GUNTZ, M. Antimoine. *In* Frémy, Enc. chim., Vol. 3 (11e cahier), pp. 403–12 (1884).

HALSE, EDWARD. Antimony Ores. London, Murray, 102 pp. (1925). (154 ref. arranged by country, pp. 93–102.)

LEBEAU, P. Antimoine. *In* Moissan, Chim. min., Vol. 2, pp. 1–54 (1905). (845 footnotes.)

MELLOR, J. W. Antimony. *In* Inorg. Theor. Chem., Vol. 9, pp. 339–90 (1929). Includes history (40 ref.); occurrence (300 ref.); extraction (200 ref.); allotropic forms (40 ref.); physical properties (600 ref.); chemical properties (250 ref.); atomic weight (40 ref.).

MICHEL, H. Gediegen Antimon. *In* Doelter, Handb. Mineralchem., Vol. 3, Pt. 1, pp. 743–56 (1918). (Bibl. footnotes.)

SCHENK. Antimon und seine Verbindungen. *In* Abegg, Handb. anorg. Chem., Vol. 3, Pt. 3, pp. 623–27 (1907). (Classified.)

U. S. TARIFF COMMISSION. Antimony. *In* Tariff Information Surv., No. 21, pp. 44–46 (1920). (55 ref.)

WANG, CHUNG YU. Antimony, Its History, Chemistry, Mineralogy, Geology, Metallurgy, Uses, Preparation, Analysis, Production, and Valuation; with Complete Bibliographies. 2nd ed. London, Griffin, 217 pp. (1919). (674 ref. covering the years 1817–1908.)

WANG, CHUNG YU. Bibliography of Antimony from 1909–1917. Shanghai, Commercial Press, 26 pp. (1917). (250 ref.; continuation of the above bibl.)

WANG, CHUNG YU. Bibliography of Antimony, 1917–1924. *Jour. Assn. Chinese and American Eng.*, **6**, 14–34 (1925). (420 ref., classified.)

Antimony Oxides

EPHRAIM, F. Antimonpentoxyd. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 3, Pt. 2, pp. 688–96 (1908). (Ref. through text.)

EPHRAIM, F. Antimontrioxyd. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 3, Pt. 2, pp. 678–88 (1908). (Ref. through text.)

MELLOR, J. W. The Antimonious Acids and the Antimonites. *In* Inorg. Theor. Chem., Vol. 9, pp. 433–34 (1929). (75 ref.)

MELLOR, J. W. Antimonious Oxide or Antimony Trioxide. *In* Inorg. Theor. Chem., Vol. 9, pp. 427–28 (1929). (250 ref.)

MELLOR, J. W. Antimony Pentoxide and the Antimonic Acids. *In* Inorg. Theor. Chem., Vol. 9, p. 446 (1929). (100 ref.)

MELLOR, J. W. Antimony Tetroxide and the Hypo-antimonates. *In* Inorg. Theor. Chem., Vol. 9, pp. 438–39 (1929). (150 ref.)

MICHEL, H. Antimonoxyde. *In* Doelter, Handb. Mineralchem., Vol. 3, Pt. 1, pp. 756–65 (1918). (Bibl. footnotes.)

Barium

BURR, MAY S. Barium and Its Compounds. *In* Friend, Textbook Inorg. Chem., Vol. III, Pt. 1, pp. 196–265 (1925). (Bibl. footnotes.)

DOELTER, C. Baryt. *In* Doelter, Handb. Mineralchem., Vol. 4, Pt. 2, pp. 227–51 (1929). (Bibl. footnotes.)

GUNTZ, A. Sur la Préparation du Baryum. *Chimie et industrie* (Special No., 462 pp., Feb., 1929). (47 ref.)

Bauxite

BRANNER, J. C. Bibliography of Bauxite. *Jour. Geol.*, **5**, 285–89 (1897). (93 ref.)

DITTLER, E. Bauxite und Laterit. *In* Doelter, Handb. Mineralchem., Vol. 3, Pt. 2, pp. 481–510 (1926). (Bibl. footnotes.)

DITTLER, E., AND DOELTER, C. Bauxite, ein naturliches Tonerdehydrogel. *Kolloid-Z.*, **9**, 282–90 (1911). (28 footnotes.)

EDWARDS, J. D., FRARY, F. C., AND JEFFRIES, Z. Bauxite and Laterite. *In* Aluminium Industry, Vol. I, pp. 120–23 (1930).

FOX, CYRIL S. Bauxite: a Treatise Discussing in Detail the Origin, Constitution, Known Occurrences, and Commercial Uses of Bauxite and Including Particulars Regarding the Present Condition of the Aluminium Industry and the Peculiar Importance of Cryolite in the Extraction of Aluminium from Bauxite. Lockwood, 1927. (Bibl., pp. 270–304.)

FOX, CYRIL S. The Bauxite and Aluminous Laterite Occurrences of India. Memoirs, Geol. Surv. India, Vol. 49, Pt. 1, pp. 222–87 (1923).

KNIBBS, N. V. S. Industrial Uses of Bauxite. London, Benn, 141 pp. (1928). (Bibl. at end of each chapter.)

MORSE, PAUL F. The Bauxite Deposits of Mississippi. Miss. State Geol. Surv., *Bull.*, No. 19, 208 pp. (1923). (Bibl. ref.)

PHALEN, W. C. Bauxite and Aluminium. U. S. Geol. Surv., *Mineral Resources*, Pt. 1, pp. 208–209 (1914). (46 ref., covering the years 1892–1911.)

RUMBOLD, W. G. Bauxite and Aluminium. London, Murray, 110 pp. (1925). (Bibl. of 114 ref. arranged by country, pp. 105–10.)

WATSON, O. L. Preliminary Report on the Bauxite Deposits of Georgia. Georgia Geol. Surv., *Bull.*, No. 11, 169 pp. (1904). (Bibl., pp. 159–64; 82 ref.)

Bentonite

DAVIS, C. W., AND VACHER, H. C. Bentonite, Its Properties, Mining, Preparation, and Utilization. U. S. Bur. Mines, *Tech. Paper*, No. 438, 51 pp. (1928). (105 footnotes.)

SPENCE, HUGH S. Bentonite. Canada, Dept. Mines, Mines Branch, 35 pp. (1924). (Bibl., pp. 32–35.)

Beryllium

CLE E, P. T. Le glucinium et ses composés. *In* Frémy, Enc. Chim., Vol. 3 (5e cahier), pp. 23–25 (1884).

DAWSON, H. M. Beryllium. *In* Abegg, Handb. anorg. Chem., Vol. 2, Pt. 2, pp. 24–25 (1905). (57 ref., covering the years 1798–1904.)

ENGLE, E. A., AND HOPKINS, B. S. The Metallurgy and Alloys of Beryllium. *Trans. Amer. Electrochem. Soc.*, **45**, 255–62 (1924). (23 footnotes.)

EPHRAIM, FRITZ. Beryllium. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 2, Pt. 2, pp. 515–55 (1909). (Ref. through text.)

LEBEAU, P. Glucinium. *In* Moissan, Chim. min., Vol. 3, pp. 886–905 (1904). (220 footnotes.)

MELLOR, J. W. Beryllium or Glucinium. *In* Inorg. Theor. Chem., Vol. 4, pp. 204–48(1923). (Ref. through chapter.)

MIGLIACCI, D. Il berillio. *Giorn. chim. ind. appl.*, **12**, 23–27, 83–87 (1930). (109 footnotes.)

NEGRU, J. S. Glucinum. *Chem. Met. Eng.*, **21**, 353–59 (1919). (33 ref.)

PARSONS, C. L. Chemistry and Literature of Beryllium. Chem. Pub. Co., Easton, Pa., 180 pp. (1909). (Bibl., pp. 72–168.)

SIEMENS AND HALSKE, A. G. Beryllium-Arbeiten. Wissenschaftliche Veröffentlichungen aus dem Siemens-Konzern, VIII, No. 1. Berlin, Springer, 256 pp. (1929). ("Ref. are numerous.")

Beryllium Silicates

DOELTER, C. Beryllium-Aluminiumsilicate. *In* Handb. Mineralchem., Vol. 2, Pt. 2, pp. 583–602 (1917). (Bibl. footnotes.)

DOELTER, C. Berylliumsilicate. *In* Handb. Mineralchem., Vol. 2, Pt. 1, pp. 276–88 (1914). (Bibl. footnotes.)

MELLOR, J. W. Beryllium Aluminium Silicates. *In* Inorg. Theor. Chem., Vol. 6, pp. 806–808 (1925). (About 150 ref.)

MELLOR, J. W. Beryllium or Glucinium Silicates. *In* Inorg. Theor. Chem., Vol. 6, pp. 383–84 (1925). (About 100 ref.)

Bismuth

ALLEN, ROBERT. Bismuth Ores. London, Murray, 62 pp. (1925). (Bibl., pp. 57–62, 80 ref.)

BISMUTH. U. S. Bureau of Standards, *Circ.*, No. 382, 41 pp. (1930). (Bibl. of 246 ref. on pp. 31–41.)

MELLOR, J. W. Bismuth. *In* Inorg. Theor. Chem., Vol. 9, pp. 587–634 (1929). Includes history (40 ref.); occurrence (150 ref.); extraction (125 ref.); physical properties (1000 ref.); chemical properties (200 ref.); atomic weight (75 ref.).

Wismut und radioaktive Isotope. *In* Gmelin's Handb. anorg. Chem., Vol. 8 (Aufl. System), No. 19, 229 pp. (1927).

Bismuth Oxides

MELLOR, J. W. Bismuth Monoxide and Trioxide. *In* Inorg. Theor. Chem., Vol. 9, pp. 651–53 (1929). (About 175 ref.)

MELLOR, J. W. The Higher Oxides of Bismuth. *In* Inorg. Theor. Chem., Vol. 9, pp. 658–59 (1929). (About 75 ref.)

Borates

D'ACHIARDI, G. Borate. *In* Doelter, Handb. Mineralchem., Vol. 3, Pt. 2, pp. 400–35 (1926). (Bibl. footnotes.)

DUKELSKI, M. Über Borate. *Z. anorg. Chem.*, **50**, 38–48 (1906). (31 ref. on the Na, K, and Li salts.)

GREAT BRITAIN IMPERIAL MINERAL RESOURCES BUREAU. Mineral Industry of the British Empire and Foreign Countries. War Period. Borates. (1913–1919.) 24 pp. (1920). (Bibl., pp. 23–24.)

Borax

BAILEY, G. E. Saline Deposits of California. Calif. State Mining Bur., *Bull.*, No. 24, 216 pp. (1902). (Bibl., pp. 193–94; 41 ref.)

LADOO, R. B. Borax and the Borates. *In* Nonmetallic Minerals, pp. 110–11 (1925).

NASINI, RAFFAELLO. I soffioni boraciferi e la industria dell'acido borica in Toscana. Rome, Bertero, 124 pp. (1907). (Bibl., pp. 119–24.)

U. S. LIBRARY OF CONGRESS. List of Ref. on Borax. 10 pp. (1925). (Typewritten.)

YALE, CHAS. G., AND GALE, HOYT S. Borax. U. S. Geol. Surv., *Mineral Resources*, Pt. 2, pp. 523–36 (1913); Pt. 2, pp. 289–90 (1914). (About 150 titles.)

Boric Acid

"Boric Acid." Ind.-Cat. S. G. O., 1st Ser., No. 1, pp. 74–75 (1880); 2nd Ser., No. 1, p. 102 (1896); 3rd Ser., No. 1, pp. 108–109 (1918).

GUTBIER, A. Borsäure. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 1, Pt. 3, pp. 413–36 (1911). (Ref. through text.)

MELLOR, J. W. Boric Acid and Borates. *In* Inorg. Theor. Chem., Vol. 5, pp. 62–64, 81–83, 85, 94–95, 101–102, 104, 106–107, 111, 115 (1924).

NASINI, R. Sassolin (Borsäure). *In* Doelter, Handb. Mineralchem., Vol. 3, Pt. 2, pp. 375–400 (1926). (Bibl. footnotes.)

Boron

BOR. Gmelin's Handb. anorg. Chem., Vol. 8, Aufl., No. 13. Leipzig, Verlag Chemie, 142 pp. (1926). (Literature through 1925.)

KAHLENBERG, HERMAN H. Boron and Boron Suboxide. *Trans. Amer. Electrochem. Soc.*, **47**, 23–55 (1925). (27 footnotes.)

Borosilicates

MELLOR, J. W. The Borosilicates. *In* Inorg. Theor. Chem., Vol. 6, pp. 451–53 (1923). (About 250 ref.)

Brick

CARNEGIE LIBRARY OF PITTSBURGH. Brick Manufacture and Bricklaying. *In Monthly Bulletin*, **17**, No. 1, 24 pp. (1912). (Does not cover fire brick.)

GRUNWELL, PAUL C. Studies of Machines for Extruding Clay Columns. Augers, Spacers, and Dies for Brick Machines. Bur. Stand., *Jour. Research*, **1**, 1055–57 (1928).

NATIONAL BRICK MANUFACTURERS' ASSOCIATION, U. S. A Study of the Chemical Status of the Carbon, Iron, and Sulphur in Clays during the Various Stages of Firing. Third Rept. of Comm. on Tech. Invest. Indianapolis, Randall, 108 pp. (1908). (Bibl., pp. 20–21; bibl. footnotes.)

SEARLE, A. B. Clayworkers' Handbook. 2nd ed. London, 394 pp. (1911).

Brick, Silica

CELLERIER. Résumé des travaux sur la fabrication des briques de silice. Paris (1919).

Cadmium

BUDGEN, NORMAN F. Cadmium: Its Metallurgy, Properties, and Uses. London, Griffin, 239 pp. (1924). (Ref. at end of most chapters.)

Cadmium. Gmelin's Handb. anorg. Chem., 8th ed. System-Nummer 33. Leipzig Verlag Chemie, 214 pp. (1925). (Bibl. through text; covers the metal and its compounds, through June, 1924.)

GREGORY, J. C., AND BURR, M. S. Cadmium and Its Compounds. *In* Friend, Textbook Inorg. Chem., Vol. III, Pt. II, pp. 159–200 (1926). (Bibl. footnotes.)

MELLOR, J. W. Zinc and Cadmium. *In* Inorg. Theor. Chem., Vol. 4, pp. 398–694 (1923). (Extensive bibls. through text.)

SIEBENTHAL, C. E., AND STALL, A. Cadmium. Mineral Resources of U. S., Pt. I, pp. 10–11 (1924).

TYLER, PAUL M. Cadmium. Mineral Resources of the U. S., Pt. I, pp. 336–39 (1927).

Cadmium Carbonate

MELLOR, J. W. Zinc and Cadmium Carbonates. *In* Inorg. Theor. Chem., Vol. 4, pp. 648–50 (1923). (About 160 ref.)

Calcium Phosphates

BASSETT, HENRY, JR. Beitrage zum Studium der Calciumphosphate. *Z. anorg. Chem.*, **59**, 1–55 (1908). (Bibl. footnotes.)

BRAUNS, R. Über den Apatit aus dem Laacher Seegebiet. Sulfatapatit und Carbonatapatit. *Neues Jahrb. Mineral. Geol.*, **41**, 60–92 (1916–1917). (Bibl. footnotes.)

EPHRAIM, FRITZ. Calcium und Phosphor. *In* Gmelin-Kraut., Handb. anorg. Chem., Vol. 2, Pt. 2, pp. 286–307 (1909). (Ref. through text.)

HOLT, L. EMMETT, JR., LA MER, VICTOR K., AND CHOWN, H. BRUCE. The Solubility Product of Secondary and Tertiary Calcium Phosphate under Various Conditions. *Jour. Biol. Chem.*, **64**, 564–65 (1925). (37 ref.)

PENROSE, R. A. F. Nature and Origin of Deposits of Phosphate of Lime. U. S. Geol. Surv., *Bull.*, No. 46 (1888). (Bibl., pp. 129–40.)

ROBINSON, C. S. Use of Solutions of Ammonium Citrate for the Estimation of Reverted Calcium Phosphate. Mich. Agr. Expt. Sta., *Bull.*, No. 46, pp. 3–29 (1919). (54 ref.)

SEEBACH, M. Calciumphosphate. *In* Doelter, Handb. Mineralchem., Vol. 3, Pt. 1, pp. 323–52 (1918). (Bibl. footnotes.)

Cement

ABRAMS, DUFF A. Brief Bibliography on Portland Cement. *Proc. Amer. Soc. Testing Materials*, **25** [1], 172–77 (1925).

ABRAMS, DUFF A. Effect of Storage on Cement. Structural Materials Research Lab., Lewis Inst., *Bull.*, No. 6, 38 pp. (1924). 2nd ed. (Bibl., pp. 35–38.)

ARLT, FERDINAND R. v. Allgemeines über Zemente. *In* Doelter, Handb. Mineralchem., No. 1, pp. 851–54 (1912). (106 ref. to books.)

ATWOOD, WM. G., AND JOHNSON, A. A. Disintegration of Cement in Sea Water. *Proc. Amer. Soc. Civil Eng.*, **49**, 1058–64 (1923). 114 ref. *Also in their* Marine Structures, pp. 496–519 (1924).

BATES, P. H., AND EMLEY, W. E. Structural Cements, Limes, and Plasters. International Critical Tables, Vol. II, p. 124 (1927). (50 ref.)

BATES, P. H., PHILLIPS, A. J., AND WIG, R. J. Action of the Salts in Alkali Waters and Sea Water on Cements. U. S. Bur. Stand., *Tech. Paper*, No. 12, 157 pp. (1912). (Bibl., pp. 103–105; 100 ref.)

BERGER, E. E. Calcium Sulphate Retarders for Portland Cement. U. S. Bur. Mines, *Rept. of Invest.*, No. 2705, Sept., 1925. (18 ref.)

BERL, E., AND LÖBLEIN, FR. Beitrag zur Kenntnis der tonerdereichen Schmelzzement. *Zement*, **15**, 642–43, 673–77, 741–45, 759–62, 783–85 (1926). (50 footnotes.)

BOGUE, R. H. Digest of the Literature on the Constitution of Portland Cement Clinker. Portland Cement Assn. Fellowship, Paper No. 3, 66 pp. (1927). (Bibl., pp. 63–66, 71 ref.; reprinted from *Concrete*, 1926–1927.)

BOGUE, R. H. Digest of the Literature on the Nature of the Setting and Hardening in Portland Cement. *Rock Prod.*, **31**, [10], 69–71; [12], 62–63; [14], 61–62; [16], 67–70; [18], 65–68; [20], 65–68 (May–Sept., 1928); Portland Cement Assn. Fellowship, Paper No. 17, 48 pp. (1928). (70 ref., pp. 47–48.)

BURCHARD, E. F., AND BAGLEY, B. W. Cement in 1923. U. S. Geol. Surv., *Mineral Resources*, Vol. II, pp. 318–25 (1923). (About 200 ref. on cement materials, cement, and concrete.)

BURCHARTZ, R. F. Use of Trass for Cement and as an Addition to Concrete. *Zement*, **12**, 269–71 (1923).

CANDLOT, E. Ciments et chaux hydrauliques, fabrication—propriétés—emploi. 3rd ed. Paris, Béranger, 531 pp. (1906). (Bibl., pp. 523–25.)

COCHRAN, JEROME. A Treatise on Cement Specifications. N. Y., Van Nostrand, 101 pp. (1912). (Bibl., pp. 82–94.)

CRUM, R. W. Bibliography on Quick Hardening Cements. Proc. 5th Annual Meeting Highway Research Board, National Research Council, Pt. I, pp. 170–72 (1926).

DAVIS, R. E. Summary of Results of Investigations Having to Do with Volumetric Changes in Cements, Mortars, and Concretes, Due to Causes Other Than Stress. *Jour. Amer. Concrete Inst.*, **1**, 440–43 (1930).

DIEPSCHLAG, E., AND MATTING, A. Die Bestimmung des frien Kalkes in Schlacken und Zementen. *Zement*, **17**, 1375–76 (1928). (129 ref.)

DITTLER, E. Die Silicate und Aluminate des Zements. *In* Doelter, Handb. Mineralchem., **1**, 804–14 (1912). (Bibl. footnotes.)

ECKEL, C. E. Portland Cement Materials and Industry in the U.S. U. S. Geol. Surv., *Bull.*, No. 522. (Bibl., pp. 375–81. 125 ref. covering the years 1888–1912.)

ECKEL, EDWIN C. Cements, Limes, and Plasters; Their Materials, Manufacture, and Properties. 3rd ed., with chapters on alumina cements and high-strength Portlands. N. Y., Wiley, 699 pp. (1928). (Ref. at end of some of the chapters.)

ENDELL, K. Wichtigste Literatur über Zementforschung seit 1908. *Z. angew. Chem.*, **31**, 240 (1918). (59 ref.)

FRENKEL, G. Kolloidchemische Technologie des Portlandzementes. *In* Liesegang, Kolloidchem. Tech., pp. 625–33 (1927). (Bibl. footnotes.)

GESSNER, HERMANN. Das Abbinden des Zementes. *Kolloid-Z.*, **46**, 207–16 (1928). (60 footnotes.)

GOVERNMENT and State Publications on Cement Materials, Cement, and Concrete. U. S. Geol. Surv., *Mineral Resources*, Pt. 2, pp. 371–75 (1916). (138 ref. covering the years 1888–1917.)

HALEN, S. Im Gewerbe, in der Industrie und im Haushalt verwendbare Kitte. *Kunststoffe*, **2**, 321–25, 368–71 (1912). Patents.

HATT, W. K., AND MILLS, R. E. Physical and Mechanical Properties of Portland Cements and Concretes. Purdue Univ., Eng. Expt. Sta., *Bull.*, No. 34, 99 pp. (1928). (Bibl., pp. 91–95, 94 ref.)

HEMMING, ÉMILE. Calcareous Cements and Artificial Stones. *In* Plastics, pp. 42–90 (1923). (Patents.)

HURSH, R. K. Cements, Limes, and Plasters. *Jour. Ind. Eng. Chem.*, **13**, 477–78 (1921).

KALLAUNER, O. Portland Cement and Magnesium Salts. *Tonind.-Ztg.*, **36**, 1335–36.

KIRK, RAYMOND E. The Manufacture of Portland Cement from Marl. Univ. of Minn., Eng. Expt. Sta., *Bull.*, No. 4, 98 pp. (1926). (Bibl., pp. 93–98.)

KLEIN, A. A., AND PHILLIPS, A. J. Hydration of Portland Cement. U. S. Bur. Stand., *Tech. Paper*, No. 43, 71 pp. (1914). (60 footnotes.)

KLEINLOGEL, ADOLF. Einflüsse auf Beton; die chemischen, mechanischen, und sonstigen Einflüsse von Luft, Wassern, Säuren, Laugen, Ölen, Dämpfen, Erden, Lagergütern, u. Dgl. auf Zement, Mörtel, Beton und Eisenbeton, sowie die Massnahmen zur Verringergung und Verhütung dieser Einflüsse ein Auskunftsbuch für die Praxis. Berlin, Ernst und Sohn, 331 pp. (1925). (Bibl. footnotes.)

LESLEY, ROBERT W., LOBER, J. B., AND BARTLETT, G. S. History of the Portland Cement Industry in the United States. (With appendices covering progress of the industry by years and an outline of the organization and activities of the Portland Cement Assn.) N. Y., International Trade Press, 330 pp. (1924). (Bibl. on lime, cement, and concrete, pp. 6–8.)

MELLOR, J. W. Cement. *In* Inorg. Theor. Chem., Vol. 6, pp. 559–60 (1925). (About 75 ref.)

OTZEN, R. Hochwertiger Zement. *Zement*, **15**, 780–83 (1926). (Covers 1919 to 1926.)

PLATZMANN, C. R. Progress of Cement Research. *Zement*, **12**, 73–76, 79–82 (1923).

PLATZMANN, C. R. Zementforschung im Jahre 1928. *Zement*, **18**, 639–40 (1929). (81 ref.)

PORTLAND CEMENT ASSOCIATION. Library. Catalog of books, periodicals, and pamphlets in the library of the Portland Cement Assn. Chicago, 59 pp. (1918).

PORTLAND CEMENT ASSOCIATION. "List of research publications and paper, 1917–1928." *In* Report of the Director of Research, pp. 203–10 (1928).

RICHARDSON, CHARLES H. Cement Materials of Kentucky. Ky. Geol. Surv., Series VI, *Geologic Rept.*, Vol. 29 (1927). (Bibl., pp. 153–54.)

RICHARZ, H. Ein Überblick über die Literatur von der Konstitution des Portlandzementklinkers. *Tonind.-Ztg.*, **52**, 853–54, 1081 (1928). (81 ref.)

RICHARZ, H. Zementveredelung—Betonveredelung. *Zement*, **17**, 1348–51, 1377–82, 1411–14 (1928). (49 footnotes.)

THOMAS, W. N., AND DAVEY, N. Effect of Temperature on Setting Times of Cements and on Strength of Cements, Mortars, and Concretes. Dept. Sci. Ind. Research, Building Research Special Report, No. 13, 38 pp. (1929). (Bibl., pp. 36–38, 52 ref.)

VAIL, JAMES G. Silicate Cements. Soluble Silicates in Industry, pp. 165–209 (1928). (195 footnotes.)

WECKE, F. Handbuch der Zementliteratur. Berlin, Zementverlag, 1927. 1447 pp. A bibliography of cement, compiled for the Verein deutscher Portland-Cement-Fabrikanten. Arranged according to the kind of cement; most of the articles are annotated; patents included; name index, patent index, subject index, and also a list of periodicals and the German libraries in which these periodicals are to be found.

WITT, J. C. Effect of Electrolytes on Cement, as Reported by a Number of Investigators. *Philippine Jour. Sci.*, **13**, 30–34 (1918). (60 ref.)

See also Soil Alkalis.

Ceramics

BAUMANN, HENRY N., JR. Heat Balance Study of Ceramic Kilns. *Jour. Amer. Ceram. Soc.*, **10**, 860–96 (1927). (Bibl. footnotes; bibl., p. 896.)

Bibliography of Clay and Silica Industry. Coburg, Müller und Schmidt, 72 pp. (1928). (List of over 900 books on porcelain, stoneware, glass, enamel, etc.)

BOLLENBACH, H. Die Fortschritte der Feinkeramik. *Chem.-Ztg.*, **35**, 653–54 (1911) (43 footnotes); **37**, 1129–30, 1183–85 (1913). (61 footnotes).

BOLLENBACH, H., AND KIEFFER, E. Laboratoriumsbuch für die Tonindustrie. 2. Aufl. Halle, Knapp, 96 pp. (1929). (Bibl., pp. 92–94.)

BRANNER, JOHN C. Bibliography of Clays and the Ceramic Arts. Amer. Ceram. Soc., 1906, 451 pp. (6027 ref.). Alphabetical arrangement, supposed to cover the art from early times to the year 1906; revision of U. S. Geol. Surv., *Bull.*, No. 143 (1896).

COHN, WILLI M. Problem of Heat Economy in the Ceramic Industry. *Jour. Amer. Ceram. Soc.*, **7**, 558–62 (1924). (130 ref.)

COHN, WILLI M. Some Factors Influencing the Thermal Properties of Minerals and Products of the Ceramic Industry. *Jour. Amer. Ceram. Soc.*, **11**, 302–306 (1928). (113 ref. covering years 1919–1928.)

COHN, WILLI M. Über Wärmeleitfähigkeit, Wärmeausdehnung, spezifische Wärme und einige andere thermische Eigenschaften von Mineralien und keramischen Massen. *Ber. deut. keram. Ges.*, **9**, 239–99 (1928). (178 footnotes.)

FENAROLI, PIERO. Progressi nella chimica e tecnologia delle arti ceramiche nei 1913. *Ann. chim. appl.*, **2**, 374–90 (1914). (95 footnotes.)

FOSDICK, MARION L. Bibliography of Papers Appearing in the *Transactions, Journal*, and *Bulletin of the American Ceramic Society*, which are concerned with low temperature work and are of interest to members of the Art Division. *Jour. Amer. Ceram. Soc.*, **13**, [5], Pt. 2, pp. 59–66 (1930).

FUNK, W. Fortschritte der Keramik. *Chem.-Ztg.*, **47**, 673, 701, 718, 734, 742 (1923). (174 footnotes.)

FUNK, W. Fortschritte der Keramik in den Jahren 1923–1925. *Chem.-Ztg.*, **50**, 669–71, 683–84, 702–703, 735–37, 799–801, 827–29 (1926). (403 footnotes.)

GEYER, L. E. Revised List of Publications on Ceramic Investigations, Bureau of Mines. U. S. Bur. Mines, *Rept. of Invest.*, No. 2645, 7 pp. (1924). (Mimeographed; 90 titles; first list issued as Rept., No. 2437 (1923).)

GREAT BRIT. PATENT OFFICE. Subject List of Works on the Silicate Industries (Ceramics and Glass) in the Library of the Patent Office. London, Patent Office, 77 pp. (1914).

KOHL, H. Keramik. *In* Liesegang, Kolloidchem. Tech., pp. 577–624 (1927). (Bibl. footnotes.)

MACGEE, A. ERNEST. The Heat Required to Fire Ceramic Bodies. *Jour. Amer. Ceram. Soc.*, **9**, 206–47 (1926). (Bibl. footnotes.)

MIELDS, M. Fortschritte der Keramik. 1926–1928. *Fortschrittsber. Chem.-Ztg.*, No. 4, pp. 112–18 (1927) (133 footnotes); *ibid.*, No. 3, pp. 92–102 (1928) (245 footnotes); *ibid.*, No. 3, pp. 86–96 (1929). (206 footnotes.)

Progress in Foreign Research and Technology of Rock Products in 1928. *Rock Prod.*, **31**, 220–23 (1928). (Bibl. through text.)

Progress in Research and Technology of Rock Products in 1927. *Rock Prod.*, **31** [3], 52–56 (1928). (Bibl. through text.)

Reference List of Ceramic Books. *Jour. Amer. Ceram. Soc.*, **6**, 322–48 (1923). (Classified.)

RIEKE, R. Neuere Fortschritte auf dem Gebiete der keramischen Chemie. *Fortschritte chem.*, **6**, 141–56, 185–200 (1912–1913). (Ref. through text.)

ROEMER, MARY V. Ceramic Technology, a Selected List. St. Louis, Mo., Public Library, *Bull.*, No. 27, pp. 2–4 (1929).

SINGER, FELIX. Fortschritte der Keramik und ihre Bedeutung für die chemische Industrie. *Z. angew. Chem.*, **39**, 1279–84, 1318–21 (1926).

SINGER, F. Keramische Farben. *In* Ullmann, Enzyk. tech. Chem., 2nd ed., Vol. 4, pp. 814–38 (1929). (Several hundred footnote ref. Bibl., p. 838.)

SOCIETY OF CHEMICAL INDUSTRY. Ceramics and Building Materials. *In* Repts. of the Progress of Applied Chem., **1**, 133–49 (1916) (84 ref.); **2**, 204–41 (1917) (131 footnotes); **4**, 189–201 (1919) (54 ref.); **5**, 215–28 (1920) (84 footnotes); **6**, 228–56 (1921) (101 footnotes); **7**, 197–215 (1922) (78 footnotes); **8**, 218–32 (1923) (39 footnotes); **9**, 279–303 (1924) (95 footnotes). For later entries *see* Refractories.

SOLON, LOUIS M. E. Ceramic Literature: An Analytical Index to the Works Published in All Languages on the History and Technology of the Ceramic Art. London, Griffin, 660 pp. (1910).

SOLON, M. L. List of Books on the History and Technology of the Ceramic Art. *Trans. Ceram. Soc.* [Eng.], **11**, 65–104 (1911–1912). (Supplements the above book.)

SOUTH KENSINGTON MUSEUM (London.) Classed Catalogue of Printed Books: Ceramics. London, H. M. Stationery Office, 352 pp. (1895).

STEGER, W. Technische Fortschritte der Feinkeramik im Jahre 1927. *Keram. Rundschau*, **36**, 5–6, 44–46, 61–64 (1928). (103 ref.)

TRENTON, N. J., FREE PUBLIC LIBRARY. List of Books on Ceramics. Trenton, 30 pp. (1906).

Untersuchungs- und Prüfungsmethoden keramischen Rohstoffe und Erzeugnisse. *Ber. deut. keram. Ges.*, **8**, 44–57, 92–114 (1927). (Bibl. through text.)

WASHBURN, E. W., PARMELEE, C. W., AND HURSH, R. K. Selected List of Books

in the English Language Dealing with Ceramics. Dept. Ceramic Eng., Univ. Ill., *Bull.*, No. 42 (1921); *Jour. Ind. Eng. Chem.*, **13,** 476–78 (1921).

VOGT, G. Céramique. *In* Moissan, Chim. min., Vol. 4, pp. 61–112 (1905). (107 footnotes.)

(Serial) *Ceramic Abstracts,* Columbus, Ohio, Amer. Ceram. Soc., 1922– . (Abstracts included in the *Jour. Amer. Ceram. Soc.* without separate paging in Vol. 2, No. 6, Vol. 4 (June, 1919 to Dec., 1921). (Covers abrasives; art; cement, lime, and plasters; enamels; glass; heavy clay products; refractories; terra cotta; whiteware; apparatus and equipment; kilns, furnaces, fuels, and combustion; geology; chemistry; physics; general; includes patents.)

(Serial) Literatur-Übersicht. Beilage zu den *Berichte der deutschen keramischen Gesellschaft* (1921–).

(Serial) Silikat-Zeitschrift. Archiv für Wissenschaft und Technik der Silikate und keramisches Zentralblatt, 1913– . (Ref. classified under headings: silicate investigations, methods, firing technique, raw materials, glass, enamels, heavy clay products, lime and cement, miscellaneous.)

Chrome Refractories. *See* Refractories.

Chromite

LADOO, R. B. Chromite. *In* Nonmetallic Minerals, p. 137 (1925) (13 ref.).

Chromium

DITTLER, E., AND DOELTER, C. Chrom und Chromverbindungen. *In* Doelter, Handb. Mineralchem., Vol. 4, Pt. 2, pp. 671–743 (1929). (Bibl. footnotes.)

DOLBEAR, SAMUEL H. Chromium. *Mineral Ind.*, **25,** 100–105 (1916); **26,** 88–93 (1917); **27,** 87–92 (1918); **28,** 77–82 (1919); **29,** 88–92 (1920). (60 ref.)

GREAT BRITAIN. Imperial Mineral Resources Bureau. Mineral Industry of the British Empire and Foreign Countries. War Period. Chrome Ore and Chromium. (1913–1919). 29 pp. (1920). (Bibl., pp. 26–29.)

HÉBERT, A. Chrome. *In* Moissan, Chim. min.,Vol. 4, pp. 595–684 (1905). (930 footnotes.)

JANDER, G. Kolloide Chromverbindungen. *In* Abegg, Handb. anorg. Chem. Vol. 4, Pt. 1 (2nd half), p. 475 (1919). (20 ref.).

JOHNSTON, W. D., JR. Chromium. *Mineral Ind.*, **33,** 128 (1924); **35,** 110–11 (1927); **36,** 78–80 (1928); **37,** 81–83 (1929). (Includes alloys and chromium plating.)

KOPPEL, I. Chrom. *In* Abegg, Handb. anorg. Chem., Vol. 4, Pt. 1 (2nd half), pp. 438–67 (1919). (1408 ref., covering the years 1798–1919.)

MOISSAN, H. Le chrome et ses composés. *In* Frémy, Enc. chim., Vol. 3, 9e cahier, pp. 327–45 (1884). (Chronological, then alphabetically by author.)

POLANSKY, VICTOR S. Chromium Plating; List of References. *Brass World,* **22,** 272–73 (1926). (50 ref., annotated.)

SCHNEIDEWIND, RICHARD. Study of Patents Dealing with the Electrodeposition of Chromium. Dept. of Eng. Research, Univ. of Mich., *Eng. Research Bull.*, No. 8, 49 pp. (Patent bibl. of chromium plating, containing abstracts and comments on patents dealing with the electrodeposition of metallic chromium, pp. 23–49.)

SCHNEIDEWIND, RICHARD. Study of Chromium Plating. Univ. of Mich., *Eng. Research Bull.*, No. 10, 141 pp. (1928). (Bibl., pp. 95–121; 111 ref.)

STERN, DORA. Chrom. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 3, Pt. 1, pp. 311–701, 1319–1394 (1912). (Ref. through text.)

VALLANCE, REECE H., AND ELDRIDGE, ARTHUR A. Chromium and Its Congeners. *In* Friend, Textbook of Inorganic Chemistry, Vol. VII, Pt. 3, 380 pp. (1926).

Chromium Silicates

MELLOR, J. W. Chromium Silicates. *In* Inorg. Theor. Chem., Vol. 6, p. 866 (1925). (25 ref.)

Clay

ASHLEY, HARRISON E. The Colloid Matter of Clay and Its Measurement. U. S. Geol. Surv., *Bull.*, No. 388, 65 pp. (1909). (Bibl., pp. 59–62; 87 ref., covering years 1854–1908.)

BRADFIELD, RICHARD. The Chemical Nature of a Colloidal Clay. Thesis, Ohio State Univ., 60 pp. (1922). (Bibl., pp. 58–60.)

BRANNER, JOHN C. Bibliography of Clay and the Ceramic Arts. Amer. Ceram. Soc., 451 pp. (1906). (6027 ref.)

BROWN, GEORGE G. Clays and Shales of Michigan and Their Uses. Mich. Geol. and Biol. Surv., Publ. No. 36, Geol. Series, No. 30, 444 pp. (1926). (Bibl. footnotes.)

BUCKMAN, H. O. The Chemical and Physical Processes Involved in the Formation of Residual Clays. *Trans. Amer. Ceram. Soc.*, **13**, 364–84 (1921). (181 ref., covering years 1821–1910.)

DAVIS, N. B. Plasticity of Clay. *Trans. Amer. Ceram. Soc.*, **16**, 65–79 (1914). (46 footnotes.)

DAVIS, N. B. Plasticity of Clay and Its Relation to Mode of Origin. *Bull. Amer. Inst. Mining Eng.*, No. 98, pp. 301–30 (1915). (88 footnotes.)

DIETRICH, WALDEMAR F. Clay Resources and the Ceramic Industry of California. Calif., Dept. of Natural Resources, Div. of Mines and Mining, *Bull.*, No. 99, 383 pp. (Bibl. footnotes.)

HANCE, J. H. Note on the Occurrence and Use of Fire Clay. U. S. Geol. Surv., *Mineral Resources*, Pt. 2, pp. 645–47 (1913). (19 ref.)

HEATH, FRED T. Bibliography and Abstracts on the Utilization of Pebbly Clays for Heavy Clay Products Manufacture. *Bull. Amer. Ceram. Soc.*, **4**, 165–88 (1925). (49 ref. with extensive abstracts; annotated.)

HIND, S. R. The Plasticity of Clay. I. Mechanical Methods of Measurement. *Trans. Ceram. Soc.* [Eng.], **29**, [5], 206–207 (1930). (About 35 ref.)

HODSON, FLOYD. Origin of Bedded Pennsylvania Fire Clays in the United States. *Jour. Amer. Ceram. Soc.*, **10**, 721–46 (1927). (Bibl. footnotes; bibl., pp. 745–46.)

LADD, G. E. Preliminary Report on a Part of the Clays of Georgia. Ga. Geol. Surv., *Bull.*, No. 6A, 204 pp. (1898). (Bibl., pp. 193–99; 93 ref.)

LITTLE, H. E. V. Clay and Ceramics. *In* Friend, Textbook, Vol. 4, pp. 103–34 (1917). (Bibl. footnotes.)

MCDOWELL, J. SPOTTS. Mineral Constituents of Clay. *Jour. Amer. Ceram. Soc.*, **9**, 60 (1926). (18 ref.)

MIDDLETON, J. Clay Working Industries. U. S. Geol. Surv., *Mineral Resources*, Pt. 2, pp. 635–37 (1913); Pt. 2, pp. 545–48 (1914). (58 ref. to govt. publications.)

NIEDERLEUTHNER, RUDOLF. Unbildsame Rohstoffe keramischer Massen, Magerungsmittel, Flüssmittel und feuerfeste Stoffe. Wien, Springer, 577 pp. (1928). (Bibl. footnotes.)

POLLACK, VINCENZ. Die Beweglichkeit bindiger und nichtbindiger Materialien. Halle (Saale), Knapp, 139 pp. (1925). (Bibl. footnotes.)

RIES, H. Bibliography of Clay Deposits. *Bull. Amer. Ceram. Soc.*, **4**, 428–510 (1925). (Classified by locality.)

RIES, H. Clays of New York: Their Properties and Uses. N. Y. State Museum, *Bull.*, No. 35, 944 pp. (1900). (Bibl., pp. 908–12; 80 ref.)

RIES, H. Clays, Their Occurrence, Properties, and Uses, with Especial Reference

to Those of the United States and Canada. 3rd ed., N. Y., Wiley, 613 pp. (1927). (Contains ref.)

RIES, H. Report on the Clays of Maryland. Md. Geol. Surv., *Bull.*, No. 4, pp. 488–93 (1902). (74 ref.)

RIES, H., BAYLEY, W. S., *et al.* High Grade Clays of the Eastern United States with Notes on Some Western Clays. U. S. Geol. Surv., *Bull.*, No. 708, 305 pp. (1922). (145 footnotes.)

RIES, H., AND KÜMMEL, H. B. The Clays and Clay Industry of New Jersey. N. J. Geol. Surv., *Final Rept.*, No. 6, 548 pp. (1904). (Bibl., pp. 513–18; 76 ref.)

RIES, H., AND LEIGHTON, HENRY. History of the Clay Working Industry in the United States. New York, 270 pp. (1909). (Bibl., pp. 241–45; 172 ref.)

ROHLAND, P. Tone. *In* Abegg, Handb. anorg. Chem., Vol. 3, Pt. 1, pp. 118–119 (1906). (67 ref.)

ROSS, DONALD W. Nature and Origin of Refractory Clays. *Jour. Amer. Ceram. Soc.*, **10,** 704–20 (1927). (Bibl. footnotes; bibl., pp. 719–20.)

SALMANG, H. Ton und Wasser. *Kolloid-Z.*, **48,** 377–80 (1929). (33 footnotes.)

SEARLE, A. B. Clay and Clay Products. *In* Third Report on Colloid Chemistry, pp. 153–54 (1920).

SEARLE, ALFRED B. Clayworker's Handbook. Manual for all engaged in manufacture of articles from clay. London, Griffith (1921). (Bibl., pp. 344–54; 326 titles.)

SHAW, JOSEPH B. Fire Clays of Pennsylvania. Pa. Geol. Survey, *Bull.*, No. M-10, pp. 66–69 (1928).

TAMM, OLOF F. S. Experimental Studies on Chemical Processes in the Formation of Glacial Clay. Stockholm, Kungl. boktryckeriet, Norstedt, 20 pp. (1925). Sweden Sveriges geologiska undersokning. Ser. C. Avhandlingar och uppsatser. n:o 333; Arsbok 18 (1924) n:o 5. (Bibl., p. 20.)

TYLER, PAUL M. Clay. U. S. Bur. Mines, *Circ.*, No. 6155, pp. 53–63 (1929). (Mimeographed.)

VICKERS, A. E. J. Application of Colloid Chemistry to the Study of Clays. *Trans. Ceram. Soc.* [Eng.], **28,** 97–100, 143–47 (1929). (151 ref.)

WHEELER, H. A. Clay Deposits. Missouri Geol. Surv., *Bull.*, No. 11, 622 pp. (Bibl., pp. 603–10; 174 titles.)

WIESE, OTTO. Die Anfarbemethode in der Keramik und bei Mineraluntersuchungen. Diss., Tech. Hochschule, Berlin, No. 47, pp. 109–55 (1927). (Bibl., pp. 153–55.)

WILSON, HEWITT. Ceramics; Clay Technology. N. Y., McGraw-Hill, 296 pp. (1927). (Contains ref.)

YEATES, W. S. Clay and Its Manufacture. Georgia Geol. Surv., *Bull.*, No. 6A, (1898). (Bibl., pp. 193–99; 93 ref.)

Cobalt

COPAUX, H. Cobalt. *In* Moissan, Chim. min., Vol. 4, 144–244 (1905). (675 footnotes.)

DRURY, CHARLES W. Cobalt, Its Occurrence, Metallurgy, Uses, and Alloys. Rept. Ontario Bur. Mines, No. 27, Pt. 3, Sec. 1, 133 pp. (1918). (Contains bibls.)

DRURY, C. W. Cobalt. *Mineral Ind.*, **28,** 137–39 (1919); **29,** 139–41 (1920); **30,** 142–45 (1921). (34 ref.)

DRURY, C. W. Cobalt. *Mineral Ind.*, **35,** 152–53 (1927); **36,** 115–16 (1928); **37,** 121–22 (1929).

FRIEND, J. NEWTON. Cobalt. *In* Textbook, Vol. 9, Pt. 1, pp. 19–77 (1920). (Bibl. footnotes.)

GREAT BRITAIN. Imperial Mineral Resources Bureau. Mineral Industry of the

British Empire and Foreign Countries. Cobalt, 1913–1919. 22 pp. (1921.) (Bibl., pp. 20–22.)

HALSE, EDWARD. Cobalt Ores. (Imperial Inst. Monograph.) London, Murray, 54 pp. (1924).

KALMUS, H. T., HARPER, C. H., AND SAVELL, W. L. Electroplating with Cobalt. *Trans. Amer. Electrochem. Soc.*, **37**, 75–130 (1915). (Bibl. footnotes.)

MEUNIER, M. J. Cobalt. *In* Frémy, Enc. chim., Vol. 3, 12e cahier, pp. 267–73 (1889).

ROTH, W. Kobalt. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 5, Pt. 1, pp. 190–586, 1441–1544 (1909). (Ref. through text.)

WATTS, OLIVER P. The Electrodeposition of Cobalt and Nickel. *Trans. Amer. Electrochem. Soc.*, **23**, 150–52 (1913). (100 ref.)

Cobalt Oxide

HUTTNER, ERWIN. Beiträge zur Kenntniss der Oxyde des Kobalts. *Z. anorg. Chem.*, **27**, 81–124 (1901). (50 footnotes.)

ROTH, W. Kobalt und Sauerstoff. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 5, Pt. 1, pp. 204–14 (1909). (Ref. through text.)

WITTEVEEN, H. J., AND FARNUA, E. F. Colors Developed by Cobalt Oxides. *Jour. Ind. Eng. Chem.*, **13**, 1061–66 (1921).

Copper Fluorides

MELLOR, J. W. Copper Fluorides. *In* Inorg. Theor. Chem., Vol. 3, pp. 154–56 (1923). (40 ref.)

PETERS, FRANZ. Kupfer und Fluor. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 5, Pt. 1, pp. 884–87 (1909).

Copper Hydroxides

MELLOR, J. W. Copper Hydroxides. *In* Inorg. Theor. Chem., Vol. 3, pp. 141–47 (1923). (100 ref.)

Copper Oxides

MELLOR, J. W. Copper Suboxides; Cupric Oxide. *In* Inorg. Theor. Chem., Vol. 3, pp. 116–41 (1923). (600 ref.)

Corundum

BARLOW, A. E. Corundum, Its Occurrence, Distribution, Exploitation, and Uses. Canada Geol. Surv., *Mem.*, No. 57 (Geol. Ser., No. 50), 377 pp. (1915). (Bibl., pp. 317–24; 68 ref.)

EARDLEY-WILMOT, V. L. Bibliography on Corundum. *In* Abrasives, Pt. II; Corundum and Diamond (Canada, Dept. of Mines, Mines Branch, Publ., No. 677, p. 35 (1927).

HOLLAND, T. H. Corundum. *In* Ball, A Manual of the Geology of India. Economic Geology. 2nd ed. Pt. 1. Corundum. Calcutta, 79 pp. (1898). (Bibl., pp. 62–65; 59 titles.)

LADOO, R. B. Corundum and Emery. *In* Nonmetallic Minerals, pp. 174–75 (1925). (30 ref.)

LEWIS, J. V. Corundum and the Basic Magnesian Rocks of Western North Carolina. N. C. Geol. Surv., *Bull.*, No. 11, 107 pp. (1896). (Bibl., pp. 99–101; 60 ref.)

PRATT, J. H., AND LEWIS, J. V. Corundum and the Peridotites of Western North Carolina. N. C. Geol. Surv., Vol. 1, 464 pp. (1905). (Bibl., pp. 401–20; 393 ref.)

Cryolite. *See* Fluorspar.

Dental Cements

VOELKER, CHARLES C. Dental Silicate Cements in Theory and Practice. *Dental Cosmos*, **58**, 1098–1111 (1916).

Dental Chemistry

GIBSON, CHARLES S. The Chemistry of Dental Materials. London, Benn, 176 pp. (1922). (Bibl. footnotes.)

Diatomaceous Earth

CALVERT, R. Diatomaceous Earth. N. Y., Chem. Cat. Co., 251 pp. (1930). (Several hundred footnotes.)

DAVIS, C. W. Diatomaceous Earth, with Special Reference to Nevada. U. S. Bur. Mines, *Rept. of Invest.*, No. 2718, 14 pp. (1925). (Bibl., pp. 12–14.)

EARDLEY-WILMOT, V. L. Diatomite, Its Occurrence, Preparation, and Uses. Canada, Dept. Mines, Mines Branch, No. 691, 182 pp. (1928). (Bibl., pp. 143–51, classified.)

GOODWIN, NORRIS. Diatomaceous Earth. *Chem. Met. Eng.*, **23**, 1159–60 (1920). (150 ref., including patents.)

PELLETAN, JULES. Les diatomées. Histoire naturélle, préparation, classification, and description des principales espèces. Paris, *Journal de micrographie*, 1888–1889. ("Bibl. des diatomées," Vol. ii, pp. 200–350, "principales publ. périodiques," Vol. ii, pp. 351–52.)

Dielectrics

BUSH, V., AND MOON, P. H. Precision measurement of puncture voltage. *Trans. Amer. Inst. Elec. Eng.*, **46**, 1034–35 (1927). (53 ref.)

CURTIS, HARVEY L. The Electrical Resistivity of Insulating Materials. *Trans. Amer. Inst. Elec. Eng.*, **46**, 1046–47 (1927). (74 ref.)

CURTIS, H. L., AND DEFANDORF, F. M. Dielectric Constant and Dielectric Strength of Elementary Substances, Pure Inorganic Compounds, and Air. International Critical Tables, Vol. VI, pp. 80–81 (1929). (158 ref.)

MALTI, M. G. Bibliography of Solid Dielectrics. *Sibley Jour.*, **43**, 243–49 (1929).

RAYNER, E. H. High Voltage Tests and Energy Losses in Insulating Materials. *Jour. Inst. Elec. Eng.*, **49**, 53–71 (1912).

WHITEHEAD, JOHN B. Lectures on Dielectric Theory and Insulation. N. Y., McGraw-Hill, 154 pp. (1927). (Bibl. by subject, pp. 141–50.)

Dolomite

EPHRAIM, FRITZ. Dolomit. Calciummagnesiumkarbonat. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 2, Pt. 2, pp. 510–12 (1909).

LEITMEIER, H. Dolomit. *In* Doelter, Handb. Mineralchem., Vol. 1, pp. 360–402 (1912). (Bibl. footnotes.)

LINCK, G. Die Experimente zur Darstellung des Dolomits. Hypothesen über die Entstehung des Dolomits. *In* Doelter, Handb. Mineralchem., Vol. 1, pp. 136–38 (1912). (120 ref.)

Enamels

COOKE, R. D. Bibliography of the Literature on Plasticity and Setting Up of Enamel Slips. *Bull. Amer. Ceram. Soc.*, **5**, 232–34 (1926).

DANIELSON, R. R., AND WOLFRAM, H. G. Vitreous Enamels for Metals. International Critical Tables, Vol. II, p. 117 (1927). (32 ref.)

FISCHER, W. Die Emailtechnik und Emailwissenschaft im Jahre 1927. *Keram. Rundschau*, **36**, 5 (1928). (70 ref.)

LANDRUM, R. D., AND CARTER, H. D. Bibliography and Abstracts of Literature on Enamels. Columbus, Amer. Ceram. Soc., 385 pp. (1929). (Alphabetical, with subject index. Includes about 400 patents.)

PURDY, ROSS C. Chemical Rôle of Boron in Glazes. *Trans. Amer. Ceram. Soc.*, **14**, 731–39 (1912). (20 footnotes.)

RICE, B. A. Bibliography of Literature on Enamel Tests and Methods of Control. *Bull. Amer. Ceram. Soc.*, **5**, 238–41 (1926).

STALEY, HOMER F. Materials and Methods Used in the Manufacture of Enameled Cast Iron Ware. U. S. Bur. Stand., *Tech. Paper*, No. 142, 158 pp. (1919). (About 100 footnotes.)

STUCKERT, LUDWIG. Die Emailfabrikation. Berlin, Springer, 276 pp. (1929). (Bibl. of 477 ref. on pp. 260–69.)

URBSCHAT, E. Enamel Science and Enameling Technique in 1926. *Keram. Rundschau*, **35**, 7–10, 44–45 (1927).

WEST, CLARENCE J. A Reading List on Vitreous Enameling on Iron and Steel. *Jour. Amer. Ceram. Soc.*, **4**, 47–64 (1921). (About 350 ref., with annotations, covering 1907–1920.)

WEST, CLARENCE J. United States Patents Relating to Enamels with Special Reference to Enamels for Iron and Steel. *Jour. Amer. Ceram. Soc.*, **3**, 893–99 (1920). (About 100 patents, covering years 1900–1920.)

The last two papers were reprinted as Bibliographic Series, No. 7, A. D. Little, Inc., Cambridge, Mass., 27 pp. (1921).

Feldspar

ANDERSON, OLAF. Feldspat. I. Feldspatmineralenes egenskaper, forekomst og praktiske utnyttelse med saerlig henblikk pa den Norske feltspatindustri. Oslo, I kommission hos A. Aschehoug & Co., 142 pp. (1926). (Bibl., pp. 133–34.)

BAUR, EMIL. Bildung der Feldspate aus wässrigen Lösungen bei hohem Druck. *In* Doelter, Handb. Mineralchem., Vol. 2, Pt. 2, pp. 556–67 (1917). (Bibl. footnotes.)

DOELTER, C. Kalifeldspat. *In* Handb. Mineralchem., Vol. 2, Pt. 2, pp. 482–88 (1917). (Bibl. footnotes.)

GREAT BRITAIN. Imperial Mineral Resources Bureau. Mineral Industry of the British Empire and Foreign Countries. War Period. Feldspar, 1913–1919, 16 pp. (1920). (Bibl., pp. 15–16.)

JESSER, L. Chemische-technische Verwertung des Kalifeldspats. *In* Doelter, Handb. Mineralchem., Vol. 2, Pt. 2, pp. 567–79 (1917). (Bibl. footnotes.)

KIRKPATRICK, F. A. Fusion Study of the Mineral Systems Feldspar Calcite and Feldspar Magnesite. *Trans. Amer. Ceram. Soc.*, **18**, 575–618 (1916). (About 80 ref.)

LADOO, R. B. Feldspar. *In* Nonmetallic Minerals, pp. 221–22 (1925). (22 ref.)

MELLOR, J. W. The Feldspars. *In* Inorg. Theor. Chem., Vol. 6, pp. 683–91 (1925). (About 900 ref.)

SCHMID, H. S. DE. Feldspar in Canada. Canada, Dept. Mines, Mines Branch, Pub. No. 401, 125 pp. (1916). (Bibl., pp. 107–108; includes patents on the manufacture of feldspar products; 33 ref.)

Flocculation

FREE, E. Flocculation and Deflocculation. *Jour. Frank. Inst.*, **170**, 54–57 (1910). (60 ref.)

HARDY, F. Anomalous Flocculation in Colloidal Clays and Soils. *Jour. Phys. Chem.*, **30**, 254–65 (1926). (Bibl. footnotes.)

KRUYT, H. R., AND SPEK, J. VEN DER. Zur Kenntniss des Flockungsvorganges. *Kolloid-Z.*, **25**, 1–20 (1919). (46 footnotes.)

Fluorspar

ALLEN, MILTON A. Fluorspar. Arizona, Bur. Mines, *Bull.*, No. 114, 19 pp. (1921). (Bibl., pp. 18–19.)

AURAND, H. A. Fluorspar Deposits of Colorado. Colo. Geol. Surv., *Bull.*, No. 19 (1920). (Bibl., pp. 87–91; 69 ref.)

BURCHARD, E. F. Fluorspar and Cryolite. U. S. Geol. Surv., *Mineral Resources*, Pt. 2, pp. 324–25 (1916). (31 ref.)

CHERMETTE, ALEXIS. Le spath fluor dans le Massif Central; ses applications. Autun, 150 pp. (1927). (Bibl., pp. 145–50.)

DAVIS, HUBERT W. Fluorspar and Cryolite in 1919. U. S. Geol. Surv., *Mineral Resources, 1919*, Pt. 2, pp. 367–68 (1921). (40 ref.)

DAVIS, HUBERT W. Fluorspar and Cryolite in 1924. U. S. Geol. Surv., *Mineral Resources*, Pt. 2, pp. 74–76 (1924).

GREAT BRITAIN. Imperial Mineral Resources Bureau. Mineral Industry of the British Empire and Foreign Countries. War Period (1913–1919). Fluorspar, 18 pp. (1921). (Bibl., pp. 16–18.)

JOHNSTON, WM. D. Fluorspar in New Mexico. New Mexico State Bur. of Mines and Mineral Resources, *Bull.*, No. 4, 128 pp. (Bibl. footnotes.)

LADOO, RAYMOND B. Fluorspar: Its Mining, Milling, and Utilization with a Chapter on Cryolite. U. S. Bur. Mines, *Bull.*, No. 244, 185 pp. (1927). (Selected bibl. on fluorspar, pp. 172–76; cryolite, p. 180.)

Fluosilicates

MELLOR, J. W. The Fluosilicates. *In* Inorg. Theor. Chem., Vol. 6, pp. 958–60 (1925). (250 ref.)

Fusion, Heat of

DE FORCRAND, L., AND GAY, L. Latent Heat of Fusion. International Critical Tables, Vol. V, p. 135 (1929). (90 ref.)

Garnet

BRAUNS, H. Die chemische Zusammensetzung granatführender kristallinischer Schiefer, Cordieritgesteine und Sanidinite aus dem Lascher Seegebiet. *Neues Jahrb. Mineral. Geol.*, **34**, 85–175 (1912). (Bibl. footnotes.)

DOELTER, C. Granatgruppe. *In* Handb. Mineralchem., Vol. 2, Pt. 2, pp. 878–1076 (1917). (Bibl. footnotes.)

EARDLEY-WILMOT, V. L. Garnet Occurrences and Deposits in Canada. *In* Abrasives, Pt. III, Garnet. (Canada, Dept. of Mines, Mines Branch Publ., No. 677, pp. 26–34 (1927).

LADOO, R. B. Garnet. *In* Nonmetallic Minerals, pp. 255–56. (30 ref.)

See also Abrasives.

Glass

ADAMS, L. H., AND WILLIAMSON, E. D. Annealing of Glass. *Jour. Franklin Inst.*, **190**, 597–632, 835–70 (1920). (62 footnotes.)

BRADLEY, W. P., AND BROWNE, A. W. Resistance of Glass Tubing to Bursting Pressure. *Jour. Phys. Chem.*, **8**, 55 (1904); *Z. kompr. flüss. Gase*, **8**, 26 (1904). (13 footnotes.)

BUCKLEY, F. History of Old English Glass. Dingwall-Rock, N. Y., 154 pp. (1925). (Bibl., pp. 119–38, 142–51.)

CLARKE, J. R. The Electrical Properties of Glass. *Beama*, **8,** 235–38 (1921). (38 ref.)

DRALLE, ROB., AND DRALLE, CHR. Über Neuerungen in der Glas Industrie. *Chem.-Ztg.*, **24,** 464–67 (1900) (32 footnotes); **25,** 1058–60 (1901) (15 footnotes); **26,** 628–31 (1902) (33 footnotes); **27,** 98–101 (1903) (35 footnotes); **28,** 121–23 (1904) (15 footnotes); **29,** 615–18 (1905) (10 footnotes).

ECKERT, FRITZ. Über die physikalischen Eigenschaften der Gläser. *Jahrb. Radioakt. Elektronik*, **20,** 93–114 (1923). (383 ref.)

EDINBURGH. ROYAL SCOTTISH MUSEUM, LIBRARY. List of Books, etc., Relating to Glass. Edinburgh, Neill (H. M. S. Off.), 40 pp. (1893).

FENAROLI, PIERO. Progressi nella chimica e nella tecnologia del vetro nel 1913. *Ann. chim. appl.*, **1,** 446–59 (1914). (71 footnotes.)

FLUSIN, G. Bibliographie sur l'industrie du verre de silice. *Chimie & Industrie*, **5,** 270 (1921). (55 ref. and 81 patents.)

FLUSIN, GEORGES. (Silica Glass, Its Properties, History, and Manufacture.) *Le Verre*, pp. 145, 171, 193, 217, 241, 266 (1922). (Silica, 130 ref.; glass, 60 ref., and 80 patents.)

FRÉMY, ELPHEGE. Historie de la manufacture royale des glaces de France au xvii^e^ et au xviii^e^ siècle. Paris, Plon-Nourrit, 444 pp. (1909). (Bibl., pp. ix–xii.)

GOULDING-BROWN, H. Use of Boric Oxide in Glass. N. Y., Pacific Coast Borax Co., 1924. (57 ref.)

HALL, F. P. Influence of Chemical Composition on the Physical Properties of Glazes. *Jour. Amer. Ceram. Soc.*, **13,** 198–99 (1930). (42 ref.)

HARRIS, J. E., AND SCHUMACHER, E. E. Gases Evolved from Glasses of Known Chemical Composition. *Ind. Eng. Chem.*, **15,** 174–77(1923); *Bell Tech. Jour.*, **2,** 122–32 (1923). (39 ref.)

HEMMING, ÉMILE. Glass. Plastics and Molded Electrical Insulations, pp. 101–105 (1923). (Patents only.)

HERSCHKOWITSCH, M. Chemisch-technisches über Quarzglas. *In* Doelter, Handb. Mineralchem., Vol. 2, Pt. 1, pp. 157–65 (1914). (Bibl. footnotes.)

HODKIN, FREDERICK WM., AND COUSEN, A. A. Textbook of Glass Technology. London, Constable, 551 pp. (1925). (Bibl., pp. xi–xiv.)

HÜTTIG, G. F. Appareils à plaques de verre poreux soudé par fusion. *Chimie & Industrie*, **20,** 1037–38 (1928). (100 ref.)

KIRCH, T. E. Classified List of German Patents on Glass. *Glass Ind.*, **7,** 91–93 (1926).

KIRCH, T. E. Classified List of the United States Patents on Glass. *Glass Ind.*, **6,** 221–23, 254–55 (1925).

LIESEGANG, RAPHAEL ED. Glas. *In* Kolloidchem. Tech., pp. 634–74 (1927). (Bibl. footnotes.)

LIESEGANG, RAPHAEL ED. Glas. *Kolloid-Z.*, **44,** 251–58 (1928). (78 footnotes.)

LIST OF BOOKS ON GLASS. *Jour. Amer. Ceram. Soc.*, **8,** 239–47 (1925). (204 titles.)

MELLOR, J. W. Glass. *In* Inorg. Theor. Chem., Vol. 6, pp. 544–53 (1925). (About 1300 ref.)

MEYER, H. H. B. List of References on the Glass Industry. *In* the Glass Industry, Bur. of Foreign and Domestic Commerce, *Misc. Ser.*, No. 60, pp. 405–23 (1917). (460 ref., classified.)

MOREY, GEORGE W. Properties of Glass. International Critical Tables, Vol. II, p. 106 (1927). (70 ref.)

MYLIUS, WERNER. Glasforschung und Glastechnik im Jahre 1927. *Keram. Rundschau*, **36**, 43–44, 86–88, 103–105, 182–85, 223–26 (1928). (125 ref.)

QUINCKE, G. Struktur und Eigenschaften des Glases. *Ann. Physik*, **46**, 1025–53 (1915). (Bibl. footnotes.)

REBBECK, J. W., MULLIGAN, M. J., AND FERGUSON, J. B. The Electrolysis of Soda-Lime Glass. II. *Jour. Amer. Ceram. Soc.*, **8**, 337–38 (1925). (38 ref.)

ROHR, M. v. Die Entwicklungsjahre der Kunst, optisches Glas zu schmelzen. *Naturwissenschaften*, **12**, 797 (1924). (24 ref.)

ROSENHAIN, WALTER. Glass Manufacture. 2nd ed. London, Constable, 258 pp. (1919). (Bibl., pp. 244–46.)

ROSSMAN, J. Manufacture of Wire Glass as Exemplified by Patented Inventions. *Glass Ind.*, **10**, 157–62, 189–92, 222–23, 243–45, 266–69 (1929). (Lists 119 patents.)

SCHALLER, R. Glas. *In* Abegg, Handb. anorg. Chem., Vol. 3, Pt. 2, pp. 393–94 (1909). (51 ref.)

SCHULZ, HANS. Das Glas. München, Kosel, 180 pp. (1923). (Bibl., pp. 168–76.)

SCHUMACHER, EARLE E. Electrical Conductivity of Glass. *Jour. Amer. Chem. Soc.*, **46**, 1776 (1924). (27 ref.)

SILVERMAN, ALEXANDER. Alabaster Glass: History and Composition. *Jour. Amer. Ceram. Soc.*, **1**, 255–61 (1918). (Includes opal, opaque, and opalescent glass.)

SILVERMAN, ALEXANDER. Colloids in Glass. *Jour. Amer. Ceram. Soc.*, **7**, 795–802 (1924). (26 footnotes.)

SILVERMAN, ALEX., AND NECKERMAN, PAUL D. The Silvering of Glass. *Trans. Amer. Ceram. Soc.*, **17**, 12–16 (1915). (125 ref.)

SMALL, JUDSON G. The Cause of the Opalescence of Glass. *Jour. Soc. Chem. Ind.*, **34**, 402–405 (1915). (16 footnotes.)

SOCIETY OF CHEMICAL INDUSTRY. Glass. *In* Repts. of Progress of Applied Chemistry, **1**, 133–49 (1916) (84 footnotes); **2**, 204–41 (1917) (131 footnotes); **3**, 184–208 (1918) (70 footnotes); **4**, 170–77 (1919) (23 footnotes); **5**, 185–202 (1920) (84 footnotes); **6**, 198–210 (1921) (80 footnotes); **7**, 184–96 (1922) (22 footnotes); **8**, 205–17 (1923) (20 footnotes); **9**, 214–25 (1924) (13 footnotes); **10**, 220–23 (1925) (76 footnotes); **11**, 199–216 (1926) (83 footnotes); **12**, 201–17 (1927) (92 footnotes); **13**, 216–31 (1928) (115 footnotes); **14**, 235–44 (1929) (57 footnotes).

SOLON, M. L. Contributions toward a Bibliography of the Art of Glass, Glass Making and Technology, Glass Painting. *Trans. Ceram. Soc.* [Eng.], **12**, 65–77, 285–324 (1912–1913).

TOOL, A. Q., AND VALASEK, J. Concerning the Annealing and Characteristics of Glass. U. S. Bur. Stand., *Sci. Paper*, No. 358 (1920). (Bibl., pp. 570–71, covering the years 1843–1919.)

TURNER, W. E. S. Bibliographical Contribution toward the Study of the Durability of Glass. *Jour. Soc. Glass Tech.*, **1**, 213–22 (1917). (Classified.)

TURNER, W. E. S. Chemical Durability of Glass. International Critical Tables, Vol. II, pp. 113–14 (1927). (58 ref.)

TURNER, W. E. S. The Physical Properties of Glasses. The Relationship to Chemical Composition and Mode of Preparation. *Jour. Chem. Soc.*, p. 2116 (1926). (33 ref.)

WRIGHT, F. E. Synthetic and Actual Chemical Analyses of Optical Glass of Different Types. *In* The Manufacture of Optical Glass and of Optical Systems, pp. 62–65. (Ordnance Dept. Doc., No. 2037, 1921.) (117 analyses with references.)

ZSCHIMMER, E. Calculation of Glass Constants. *Jour. Soc. Glass Tech.*, **12**, 82–118, 333–66 (1928). (Bibl. footnotes.)

ZSCHIMMER, E. Glas. *In* Doelter, Handb. Mineralchem., Vol. 1, pp. 855–918 (1912). (Bibl. footnotes.)

ZSCHIMMER, E. Theorie der Glasschmelzkunst als physikalisch-chemische Technik. Jena, Thüringer Verlangsanst. u. Druckerei, 208 pp. (1924). (Bibl. footnotes.)

(Serial) *Jour. Soc. Glass Tech.*, 1917– . Abstracts classified under headings: glassmaking materials, glass manufacture and properties, lamp work and general scientific apparatus, decorated glass, optics and optical instruments, illumination and illuminating ware, fuels, refractories and furnaces, chemical analysis, machinery for the working of glass, glassware accessories, general.

Glass: Laminated

ROSSMAN, JOSEPH. American and Foreign Patents on Safety Glass. *Glass Ind.*, **10,** 35 (1929).

ROSSMAN, JOSEPH. Manufacture of Laminated Glass. *Glass Ind.*, **10,** 1–6, 28–34, 57–64, 88–90 (1929). (Patent review.)

WALSH, JAMES P. List of U. S. Patents Pertaining to Laminated Glass. *Chem. Met. Eng.*, **37,** 421 (1930). (Lists 90 patents.)

Glass sands

PETTKE, CHARLES R. Glass Sands. *Trans. Amer. Ceram. Soc.*, **19,** 160–94 (1919). (13 footnotes.)

PETTKE, CHARLES R. Glass Manufacture and the Glass Sand Industry of Pennsylvania. Pa. Geol. Surv., *Rept.*, No. 12, 278 pp. (1919). (Bibl., pp. 264–70, 129 titles.)

RICHARDSON, CHARLES H. The Glass Sands of Kentucky. Ky. Geol. Surv. (Ser. 6), **1,** 139–45 (1920). (135 ref.)

Graphite

BASTIN, EDSON S. Graphite. U. S. Geol. Surv., *Mineral Resources*, Pt. 2, pp. 736–38 (1908); Pt. 2, pp. 1102–1103 (1911); Pt. 2, pp. 246–51 (1913); Pt. 2, pp. 168–74 (1914). (About 90 different ref.)

BEACH, L. M., AND BASCOM, F. Graphite in 1919. U. S. Geol. Surv., *Mineral Resources*, Pt. 2, pp. 323–24 (1919). (14 ref.)

BINAGHI, R. Sulla graphitite. *Ann. chim. appl.*, **14,** 71–102 (1924). (108 footnotes.)

CIRKEL, FRITZ. Graphite; Its Properties, Occurrence, Refining and Uses. Canada, Dept. Mines, Mines Branch, 307 pp. (1907). (Bibl., pp. 287–89; 41 ref.)

DONATH, EDUARD. Der Graphit. Eine chemisch-technische Monographie. Leipzig, Deuticke, 175 pp. (1904). (Bibl., pp. 174–75.)

DONATH, ED. Zur Kenntniss und zur Literatur des Graphits. *Chem.-Ztg.*, **52,** 589–90, 610–11, 650 (1928). (26 footnotes.)

FERGUSON, H. G. Graphite. U. S. Geol. Surv., *Mineral Resources*, Pt. 2, pp. 117–19 (1917); Pt. 2, pp. 264–65 (1918).

GREAT BRITAIN IMPERIAL MINERAL RESOURCES BUREAU. Mineral Industry of the British Empire and Foreign Countries. War Period. Graphite, 57 pp. (1923). (Bibl., pp. 54–57.)

GUTBIER, A. Graphit. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 1, Pt. 3, pp. 472–74, 482–88, 505–10, 529–32 (1911).

HEINISCH, W., AND AMBERG, R. Graphit. *In* Doelter, Handb. Mineralchem., Vol. 1, pp. 57–96 (1912). (115 footnotes.)

KOHLSCHÜTTER, V. Über den graphitischen Kohlenstoff. *Z. anorg. allgem. Chem.*, **105,** 35–68, 121–44 (1918–1919). (Bibl. footnotes.)

LADOO, R. B. Graphite. In Nonmetallic Minerals, pp. 279–80. (30 ref.)

MELLOR, J. W. The Genesis of Graphite. *In* Inorg. Theor. Chem., Vol. 5, pp. 743–44 (1924).

MILLER, BENJ. L. Graphite Deposits of Pennsylvania. Pa. Topog. Geol. Surv., *Rept.*, No. 6, 148 pp. (1912). (Bibl., pp. 129–40, 82 ref., covering the years 1825–1911).

MOISSAN, H. Graphites. *In* Chim. min., Vol. 2, pp. 218–57 (1905). (125 footnotes.)

PENZER, N. M. Graphite. *In* Nonferrous Metals and Other Minerals, 1924. (Bibl., p. 233.)

REDFIELD, ARTHUR. Foreign Graphite in 1919. U. S. Geol. Surv., *Mineral Resources*, Pt. 2, pp. 209–10 (1919). (Classified by countries.)

RINALDO, BINAGHI. Sulla graphitite. *Ann. chim. appl.*, **14**, 71–102 (1924). (109 footnotes.)

SPENCE, H. S. Graphite. Canada, Dept. Mines, Mines Branch, *Rept.*, No. 511, 202 pp. (1920). (Bibl., pp. 195–96, 52 ref.)

TYLER, PAUL M. Graphite. U. S. Bur. Mines, *Information Circ.*, No. 6118, 45 pp. (1929). (Bibl., pp. 33–45, mimeographed.)

TYLER, PAUL M. Graphite. II. Domestic and Foreign Deposits. U. S. Bur. Mines, *Information Circ.*, No. 6122, 25 pp. (1929). (39 footnotes.)

Heat Insulation

AMERICAN SOCIETY OF REFRIGERATING ENGINEERING. Insulation Committee. Heat transmission of insulating materials; report of insulation committee, Annual meeting, 1922, rev. to 1924. Literature on thermometry, pp. 25–26. (Bibl., pp. 95–114; about 500 ref., arranged chronologically.)

CAMMERER, JOSEF S. Der Wärme- und Kälteschutz in der Industrie. Berlin, Springer, 276 pp. (1928). (Bibl., pp. 273–76.)

GRUNDHOFER, EDUARD FRANZ. Bibliography of Heat Transmission Relating Principally to Insulating and Building Materials. Pa. State Coll., Eng. Expt. Sta., *Bull.*, **33**, 37–71 (1925). (Many hundred ref., from 1690 to 1925.)

HERTER, CHARLES H. Bibliography on Heat Transmission. *Jour. Amer. Soc. Refrig. Eng.*, **6**, 379–403 (1920).

SCHOFIELD, F. H., AND HALL, J. A. Thermal Insulating Materials for Moderate and Low Temperatures. International Critical Tables, Vol. II, p. 316 (1927). (60 ref.)

Heat Transfer

BUTLER, J. B. Descriptive Bibliography on Oil and Fluid Flow and Heat Transfer in Pipes. School Mines Met., Univ. Mo., *Bull. Tech.*, Series 9, No. 4, 62 pp. (1926).

Kaolin

BAYLEY, WILLIAM S. The Kaolins of North Carolina. N. C. Geol. Survey, *Bull.*, No. 29, 132 pp. (1925). (Bibl. footnotes.)

ENDELL, K. Über die chemische und mineralogische Veränderung basischer Eruptivgesteine bei der Zersetzung unter Mooren. *Neues Jahrb. Mineral. Geol.*, **31**, 49–54 (1911). (102 ref.)

KÄSTNER, FRITZ. Das Problem der Kaolinbildung. *Sprechsaal*, **60**, 278–81 (1927). (52 ref.)

LOGAN, WM. N. Kaolin of Indiana. Ind. Dept. Conservation, Pub. No. 6, 131 pp. (1919). (Bibl., pp. 13–14.)

LONDON MUSEUM OF PRACTICAL GEOLOGY. Note on the Literature of Kaolin. *In* Handbook to the Collection of Kaolin, China Clay, and China Stone in the Museum of Practical Geology, pp. 254–59 (1914).

PIETERS, H. A. J. Dehydration of Kaolin. Thesis, Tech. Hoogeschool, Delf, 148 pp. (1928). (334 ref.)

RIEKE, REINHOLD. Kaolin. *In* Doelter, Handb. Mineralchem., Vol. 2, Pt. 2, pp. 98–103 (1917). (Bibl. footnotes.)

ROSLER, H. Beiträge zur Kenntniss einiger Kaolinlagererstätten. *Neues Jahrb. Mineral. Geol.*, **14,** 231–43 (1901). (303 ref.)

SKEEN, JOHN R. Effects of Some Electrolytes on Kaolin and the Probable Relation to the Soil. *Soil Science*, **23,** 241–42 (1927).

SMITH, RICHARD W. Sedimentary Kaolins of the Coastal Plains of Georgia. Ga. Geol. Surv., *Bull.*, No. 44, 482 pp. (1929). (Bibl., pp. 468–74.)

SPROAT, IRA E. Refining and Utilization of Georgia Kaolins. U. S. Bur. Mines, *Bull.*, No. 128, 59 pp. (1916). (Bibl., pp. 15–17.)

STREMME, H. Die Chemie des Kaolins. *Fortschr. Mineral.*, **2,** 87–128 (1912). (Bibl. footnotes.)

STREMME, H. Kaolin. *In* Doelter, Handb. Mineralchem., Vol. 2, Pt. 2, pp. 77–89 (1917). (Bibl. footnotes.)

STREMME, H. Die Genesis des Kaolins in der Literatur. *In* Doelter, Handb. Mineralchem., Vol. 2, Pt. 2, pp. 130–34 (1917). (Bibl. footnotes.)

Laterite

LUZ, A. Laterit, seine Betrachtung im Lichte der Kolloidchemie. *Kolloid-Z.*, **14,** 81–90 (1914). (41 footnotes.)

SWANSON, C. O. The Origin, Distribution, and Composition of Laterite. *Jour. Amer. Ceram. Soc.*, **6,** 1247–60 (1923). (Bibl. footnotes.)

See also Bauxite.

Magnesia Cements

ROARK, R. J. Physical Properties of Magnesia Cements and Magnesium Cement Compounds. Wisconsin Univ., Eng. Expt. Sta., *Bull.*, Vol. 8, No. 5, pp. 247–332. (Bibl., pp. 326–27; 25 ref.)

STEWART, LEROY C. Magnesia Cements and Concretes. International Critical Tables, Vol. II, p. 129 (1927). (25 ref.)

WEST, G. H., SEBASTIAN, R. L., AND DARROW, W. A. Bibliography of Magnesian Cements. U. S. Bur. Mines, *Rept. of Invest.*, No. 2534, 17 pp., mimeographed (Oct., 1923). (211 ref., classified.)

Magnesium Aluminium Silicate

DOELTER, C. Magnesium-Aluminium-Silicate. *In* Doelter, Handb. Mineralchem., Vol. 2, Pt. 2, pp. 602–35 (1917). (Bibl. footnotes.)

JACOBY, R. Magnesiumaluminiumsilikate. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 3, Pt. 1, pp. 302–308 (1912). (Ref. through text.)

Magnesium Carbonate

DOLBEAR, SAMUEL H. Magnesite. *Mineral Ind.*, **25,** 476–84 (1916); **26,** 405–14 (1917); **27,** 453–58 (1918); **28,** 433–41 (1919); **29,** 437–42 (1920); **30,** 442–48 (1921). (82 ref.)

EPHRAIM, FRITZ. Magnesiumkarbonat. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 2, Pt. 2, pp. 459–70 (1909).

GREAT BRITAIN. Imperial Mineral Resources Bureau. Mineral industry of the British Empire and foreign countries. War period. Magnesite. 42 pp. (1920). (Bibl., pp. 39–41.)

HENTON, H. M. Magnesite. *Mineral Ind.*, **35**, 442–43 (1926); **36**, 380–82 (1927). (Includes magnesium and its alloys.)

KRAFT, PHILIP. Über die genetischen Beziehungen des dichten Magnesits zu den Mineralien der Nickelsilikatgruppe. Arch. Lagerstättenforschung. No. 20, 115 pp. (1915). (Bibl., pp. 109–15; 179 ref.)

LADOO, R. B. Magnesite. *In* Nonmetallic Minerals, pp. 341–42. (30 ref.)

Magnesite and Magnesite Brick. *Jour. Amer. Ceram. Soc.*, **3**, 237–46 (1920). (Several pages of bibl.)

LEITMEIER, H. Magnesiumcarbonat. Magnesit. *In* Doelter, Handb. Mineralchem., Vol. 1, pp. 220–43 (1912). (Bibl. footnotes.)

LEITMEIR, H., AND D'ACHIARDI, G. Die Hydrate des Magnesiumcarbonats. *In* Doelter, Handb. Mineralchem., Vol. 1, pp. 261–72 (1912). (Bibl. footnotes.)

MELLOR, J. W. Magnesium Carbonate. *In his* Inorg. Theor. Chem., Vol. 4, pp. 353–54, 357–58, 366–67, 376–78 (1923). (About 600 ref.)

REDLICH, K. A. Entstehung und Vorkommen des Magnesits. Verwertung des Magnesits. *In* Doelter, Handb. Mineralchem., Vol. 1, pp. 243–61 (1912). (Bibl. footnotes).

REDLICH, KARL A. Die Bildung des Magnesits und sein natürliches Vorkommen. Fortschr., *Mineral Krist. Petr.*, **4**, 9–42 (1914). (54 ref.)

U. S. TARIFF COMMISSION. Magnesite. *In its* Tariff Information Survey, No. 20 (1920). (Bibl., pp. 118–19; 22 ref.)

WHITEWELL, G. E., AND PATTY, E. N. Magnesite Deposits of Washington. Wash. Geol. Surv., *Bull.*, No. 25 (1921). (Bibl., pp. 180–189. 160 ref. covering the years 1882–1920.)

YALE, C. G., AND GALE, H. S. Magnesite. U. S. Geol. Surv., *Mineral Resources*, Pt. 2, pp. 585–86 (1914).

Magnesium Silicates

DOELTER, C. Olivingruppe. *In* Handb. Mineralchem., Vol. 2, No. 1, pp. 294–313 (1914). (Bibl. footnotes.)

DOELTER, C. Magnesiummetasilicate. *In* Handb. Mineralchem., Vol. 2, Pt. 1, pp. 324–56 (1914). (Bibl. footnotes.)

DOELTER, C., *et al.* Magnesium Hydrosilicate. *In* Handb. Mineralchem., Vol. 2, Pt. 1, pp. 356–445 (1914). (Bibl. footnotes.)

JACOBY, R. Magnesiumsilikat. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 3, Pt. 1, pp. 255–57 (1912).

MELLOR, J. W. The Complex Silicates of Magnesium. *In* Inorg. Theor. Chem., Vol. 6, pp. 417–19 (1925). (About 375 ref.)

MELLOR, J. W. The Higher Silicates of Magnesium. *In* Inorg. Theor. Chem., Vol. 6, pp. 405–407 (1925). (About 150 ref.)

MELLOR, J. W. Hydrated Magnesium Silicates. *In* Inorg. Theor. Chem., Vol. 6, pp. 432–38 (1925). (About 750 ref.)

MELLOR, J. W. Magnesium Aluminium, Thallium, and Rare Earth Silicates. *In* Inorg. Theor. Chem., Vol. 6, pp. 826–35 (1925). (About 1200 ref.)

MELLOR, J. W. Magnesium Metasilicates. *In* Inorg. Theor. Chem., Vol. 6, pp. 399–403 (1925). (About 350 ref.)

MELLOR, J. W. Magnesium Orthosilicates. *In* Inorg. Theor. Chem., Vol. 6, pp. 388–90 (1925). (About 175 ref.)

SJÖGREN, HJ. Fluorhältige Magnesiumsilicate. *In* Doelter, Handb. Mineralchem. Vol. 2, Pt. 1, pp. 313–23 (1914). (Bibl. footnotes.)

Manganese Silicates

DOELTER, C. Mangan- und Eisenoxydulsilicate. *In* Handb. Mineralchem., Vol. 2, Pt. 1, pp. 711–22 (1914). (Bibl. footnotes.)

EPHRAIM, F. Mangansilikate. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 3, Pt. 2, pp. 389–92 (1908).

MELLOR, J. W. The Manganese Silicates. *In* Inorg. Theor. Chem., Vol. 6, pp. 901–904 (1925). (About 400 ref.)

Masonry

HOWE, MALVERD A. Masonry. New York, Wiley, 160 pp. (1915). (Bibl., pp. 150–55.)

Melting Points

BRIDGMAN, P. W. Change of Phase under Pressure. Phase Diagrams of Eleven Substances. *Phys. Rev.*, **3** [2], 126–41, 153–203 (1914).

BRIDGMAN, P. W. Effect of Pressure upon Melting and Transition Points. Volume Change on Melting and Transition. International Critical Tables, Vol. IV, 16 pp. (1928). (37 ref.)

DAY, ARTHUR L. Das Studium der Mineralschmelzpunkte. *Fortschritte Mineral.*, **4**, 115–60 (1914). (Bibl. footnotes.)

FOOTE, H. W. Triple Points, Transition Points, and Melting Points at Ordinary and Low Pressures. International Critical Tables, Vol. IV, Pt. 6, pp. 8–9 (1928). (160 ref.)

KEMPF, RICHARD. Bestimmung des Schmelzpunktes. *In* Houben-Weyl, Meth. org. Chem. (3rd ed.), Vol. I, pp. 773–825 (1925). (Bibl. footnotes.)

Points de fusion. *In* Tables Annuelles, Vol. V, pp. 104–218 (1917–1922); Vol. VI, pp. 112–47 (1923–1926).

MENGE, GEORGE A. A Study of Melting Point Determinations with Special Reference to the Melting Point Requirements of the U. S. Pharmacopœia. U. S. Hyg. Lab., *Bull.*, No. 70 (1910). (Bibl., pp. 100–101.)

Metastability

MELLOR, J. W. Undercooling, Supersaturation, and Metastability. *In* Inorg. Theor. Chem., Vol. 1, p. 456 (1922). (100 ref.)

Oil Shale

ALDERSON, VICTOR C. The Oil Shale Industry. New York, Stokes, 175 pp. (1920). (Bibl., p. 163–70; 125 ref.)

ALDERSON, VICTOR C. Directory of Oil Shale Retorts with Bibliography. Colorado School of Mines, *Quarterly*, **15** [Suppl. for Oct., 1920], 21 pp. (Bibl., pp. 18–21.)

ALDERSON, VICTOR C. The Oil Shale Industry—Selected Bibiliography. Colorado School of Mines, *Quarterly*, **16**, 27–38 (1921).

ALDERSON, VICTOR C. Oil Shale—Bibliography of Recent Articles. Colorado School of Mines, *Quarterly*, **16**, 74–76 (Oct., 1921).

ALDERSON, VICTOR C. Oil Shale—a Résumé for 1921–1923. *Railroad Red Book*, **39**, 7–14 (1922); **40**, 23–32 (1923); **41**, 11–16 (1924). Colorado School of Mines, *Circ. of Information*, 8 pp. (1922). Colorado School of Mines, *Quarterly*, **18**, No. 1 [Suppl. B], 1923. 28 pp., **19**, No. 1 (1924).

ALDERSON, V. C. Oil Shale Bibliography. Colorado School of Mines, *Quarterly*, **20**, No. 1 [Suppl. A], pp. 16–24. (About 160 ref. for 1924.)

Current Oil Shale Bibliography. *Mining Cong. Jour.*, **8**, 851, 886, 1057, 1088 (1922);

9, 37, 60, 94, 122, 202, 252, 385, 419 (1923); **10,** 142, 188, 231, 284, 304, 372, 451, 528, 560 (1924); **11,** 14, 196, 211, 406, 496 (1925); **12,** 132, 470, 603, 764 (1926).

BURROUGHS, E. H., AND GAVIN, M. J. Oil Shale. Bur. of Mines, *Rept. of Invest.*, No. 2277. (295 ref., covering period 1915–1920.) A selected bibl. is also given in *Bull.*, No. 210, pp. 185–94 (1922). (74 ref.)

CRONSHAW, HARRY B. Oil Shales. London, Murray, 80 pp. (1921). (Bibl., pp. 75–80.)

DALTON, W. H. Bibliography of British Oil Shale (including Torbanite). *Jour. Inst. Petroleum Tech.*, **2,** 178–82 (1916).

ELLS, S. C. Notes on the Economic Aspects of a Canadian Oil Shale Industry. *Can. Chem. Jour.*, **9,** 185–86 (1920). (100 ref.)

GAVIN, M. J., HILL, H. H., AND PERDEW, W. E. Notes on the Oil Shale Industry with Particular Reference to the Rocky Mountain District. U. S. Bur. Mines, *Rept. of Invest.*, No. 2256 (1921). (258 ref.)

HINDS, NORMAN E. A. The Oil Shales of Northwestern Colorado. Colo. Bur. Mines, *Bull.*, No. 8 (1919). (Bibl., pp. 47–51, 50 ref.)

MCKEE, R. H., *et al.* Shale Oil. N. Y., Chem. Cat. Co., 326 pp. (1925); (pp. 171–299 contain 1120 abstracts of articles from 1786 to 1925. Chronological with name and subject index; pp. 300–310, patents).

MCKEE, RALPH H., AND LYDER, E. E. The Thermal Decomposition of Shales. *Jour. Ind. Eng. Chem.*, **13,** 617–18 (1921). (28 ref.)

MCKEE, R. H., AND GOODWIN, R. T. Chemical Examination of the Organic Matter in Oil Shales. Colorado School of Mines, *Quarterly*, **18,** No. 1 [Suppl. A], pp. 40–41 (1923). (61 ref.)

MANNING, PAUL DEV. The Genesis of Oil Shale and Its Relation to Petroleum and Other Fuels. Thesis, Columbia Univ., 73 pp. (1927). (Bibl., pp. 35–36, 70–71.)

MUHLEN, LEO V. Die Ölschiefer des europaischen Russlands. Leipzig, Teubner, 31 pp. (1921). (Bibl., pp. 30–31.) "Oil Shale Bibliography, 1919–1920." *Railroad Red Book*, **37,** 33–36 (1920); **38,** 30–37 (1921); **42** [1], 12–15, 272 (1925).

NEUBRONNER, KARL. Beiträge zur Kenntnis des Schieferöls aus Württemburg. Diss., Technische Hochschule, Stuttgart, 95 pp. (1921). (Bibl. ref.)

THIESSEN, REINHARDT, *et al.* Oil Shales of Kentucky. A Series of Four Economic and Morphological Discussions of the Devonian Shales of This Commonwealth. Ky. Geol. Surv., Ser. 6 (1920); *Geol. Repts.*, **21,** 242 pp. (1925). (Bibl. ref.)

WINCHESTER, D. E. Oil Shale in Northwestern Colorado and Adjacent Areas. U. S. Geol. Surv., *Bull.*, No. 641 (1916). (Bibl., pp. 139–98; 26 ref.; annotated.)

WINCHESTER, D. E. Oil Shale of the Rocky Mountain Region. U. S. Geol. Surv., *Bull.*, No. 729, 204 pp. (1923). (Bibl., pp. 143–202; complete up to March 1, 1922.)

WOLDMAN, NORMAN E. The Refining of the Lower Fractions of Shale Oil by Liquid Sulphur Dioxide. Thesis, Columbia Univ., 69 pp. (1927). (Bibl., pp. 66–67.)

Phosphates

JACOB, K. D. Phosphate Rock. *Mineral Ind.*, **36,** 457–60 (1927). (70 ref.); **37,** 484–86 (1928). (56 ref.)

JOHNSON, BERTRAND L. Phosphate Rock. I. General Information. Bur. Mines, *Information Circ.*, No. 6256, 64 pp. (1930). (Bibl., pp. 19–20, 22–24; 30 ref. on technology of the industry; 28 ref. on uses.)

KIRKHAM, VIRGIL R. D. Phosphate Deposits of Idaho and Their Relation to the World Supply. Idaho, Bur. Mines and Geol., Reprint, No. 1, 28 pp.

MANSFIELD, GEORGE R. Phosphate Rock. U. S. Geol. Surv., *Mineral Resources*, Vol. II, pp. 258–61, 270–73 (1923). (70 ref.); Vol. II, pp. 98–99, 109–12 (1924). (80 ref.)

WAGGAMAN, W. H. Phosphate Rock. *Mineral Ind.*, **33**, 572–73 (1924). (20 ref.)

WEIGEL, W. M., AND STODDARD, B. H. Phosphate Rock. Mineral Resources of the U. S., Pt. II, 164 pp. (1925).

Physical Properties

CARNELLEY, THOMAS. Melting and Boiling Point Tables. London, Harrison, 2 vols., 796 pp. (1885–1887). (Values and authority; about 50,000 data.)

LANDOLT-BÖRNSTEIN. Physikalische-chemische Tabellen. 5th ed. Berlin, Springer, 1923. 2 vols. (Numerous bibls. through the work.)

Tables annuelles des constantes et donées numeriques de chimie, de physique et de technologie. Vol. 1 + 1910 to date. Contains references to all published numerical data of chemistry, physics, and engineering since 1910.

Plasticity

BINGHAM, E. C. Fluidity and Plasticity. N. Y., Chem. Cat. Co., 440 pp. (1922). (Bibl., pp. 347–429.)

LEHMANN, O. Plastizität fester Kristalle und erzwungene Homoötropie I und II Art. *Ann. Phys.*, **50**, 555–59 (1916). (Bibl. footnotes.)

PIETERS, H. A. J. Plasticiteit. *Chem. Weekblad.*, **26**, 18–24 (1929). (Bibl. footnotes.)

SLEGEL, PAUL J. Bibliography of Plasticity. *Bull. Amer. Ceram. Soc.*, **7**, 130–36 (1928). Covers the literature from 1895 to date. *See also* Enamels.

Porcelain

DIETZ, R. Porzellan. Halle, Knapp, 94 pp. (1907). (Bibl., pp. 90–91.)

GRELLIER, CAMILLE. L'industrie de la porcelaine en Limousin: ses origines son évolution. Thesis, Paris, 511 pp. (1908). (Bibl., pp. 502–508.)

KLEIN, A. A. Constitution and Microstructure of Porcelain. *Trans. Amer. Ceram. Soc.*, **18**, 377–423 (1916). (13 ref.)

RIDDLE, FRANK H., AND AUDLEY, JAMES A. Porcelain and Whiteware. International Critical Tables, Vol. II, pp. 73, 81–82 (1927). (229 ref.)

RIEKE, REINHOLD. Die Chemie des Porzellans. *In* Doelter, Handb. Mineralchem., Vol. 2, Pt. 2, pp. 94–120 (1917). (Bibl. footnotes.)

Pottery

MELLOR, J. W. Pottery. *In* Inorg. Theor. Chem., Vol. 6, pp. 518–19 (1925). (About 100 ref.)

STEGER, WALTER. Wärmewirtschaft in der keramischen Industrie. Dresden und Leipzig, Steinkopff, 147 pp. (1927). (Bibl., pp. 138–42.)

Quartz

DOELTER, C. Quartz (SiO_2). *In* Doelter, Handb. Mineralchem., Vol. 2, Pt. 1, pp. 118–57 (1914). (Bibl. footnotes.)

GROSSMANN, H. Quartz. *In* Abegg, Handb. anorg. Chem., Vol. 3, Pt. 2, pp. 368–70 (1909).

HOLDEN, EDWARD F. The Cause of Color in Smoky Quartz and Amethyst. *Amer. Mineralogist*, **10**, 250–52 (1925). (58 ref., chronological.)

JACOBY, R. Quartz. *In* Gmelin-Kraut Handb. anorg. Chem., Vol. 3, Pt. 1, pp. 131–36 (1912).

Refractories

AMERICAN CERAMIC SOCIETY. Bibliography of Magnesite Refractories. Columbus, Ohio. Amer. Ceram. Soc., 41 pp. (1924). (Chronological, 1873–1921; brief annotations.)

AMERICAN CERAMIC SOCIETY. Bibliography of Silica Refractories. Columbus, Ohio, Amer. Ceram. Soc., 125 pp. (1924).

AMERICAN GAS INSTITUTE. Bibliography of Articles on Refractory Materials. New York, Amer. Gas Inst., 104 pp. (1915). (Subject index.)

ANDERSEN, OLAF. (Physical Chemistry of Refractory Oxides.) Norg. Geol. Undersökelse, Statens Raastofkomite Pub., No. 1, 55 pp. (1922).

Bibliography of Literature on Refractories. *Jour. Amer. Ceram. Soc.*, **10**, Pt. 2, No. 2, 166 pp. (1927). (885 ref. with author and subject index, including references to Silica and Magnesite Refractories Bibls. published previously.)

BISCHOF, CARL. Die feuerfesten Tone und Rohstoffe. 4. Aufl. Leipzig, Barth, 1923. (Contains numerous bibls.)

BISCHOF, CARL. Les argiles refractaires; matières premières et leur emploi dans l'industrie des produits réfractaires. 4th ed., revue et remainiée par K. Jacob et E. Weber, avec la collaboration du Laboratoire Chimique de l'industrie de l'argile et du Journal de l'industrie de l'argile; traduction par A. Schubert. 1926. (Contains bibl. footnotes.)

BLEININGER, A. V., AND BROWN, G. H. Testing of Clay Refractories, with Special Reference to Their Load Carrying Capacity at Furnace Temperatures. U. S. Bur. Stand., *Tech. Paper*, No. 7 (1911). (About 60 footnotes.)

BLEININGER, A. V., AND LIDDELL, DONALD M. Refractories. *In* Liddell, Nonferrous Metallurgy. Vol. I, pp. 404–405 (1926). (98 ref.)

CARRIE, G. M., AND PASCOE, C. F. Magnesia Refractories for Steel Furnaces. *Can. Mining Met. Bull.*, No. 186, pp. 1268–72 (1927). (103 ref.)

CELLERIER. Résumé des travaux sur la fabrication des briques de silice. Paris (1919).

CRONSHAW, H. B. Deterioration of Refractory Materials in the Iron and Steel Industries. *Trans. Faraday Soc.*, **12**, 247–49 (1917). (50 ref.)

FERGUSON, ROBERT F. Review of the Literature on Laboratory Slag Tests for Refractories. *Jour. Amer. Ceram. Soc.*, **11**, 90–98 (1928). (53 footnotes.)

GILARD, P. Sur la conductibilité thermique des matériaux réfractaires. *Rev. univ. mines*, **4** [7], 50 (1924). (38 ref.)

GREEN, A. T. Firing Properties of Refractory Fireclay Products. *Trans. Ceram. Soc.* [Eng.], **26**, 130–31 (1926–1927). (34 ref.)

HADFIELD, R. Refractories. *Trans. Faraday Soc.*, **12**, 98–108 (1916). (About 55 books and 80 articles listed.)

HEMMING, ÉMILE. Ceramic Products. *In* Plastics and Molded Electrical Insulation, pp. 17–29 (1923). (Patents only.)

HOFMAN, H. O. Refractory Materials. *In* General Metallurgy, pp. 341–78 (1913). (Bibl. footnotes.)

HOUGEN, O. A. Refractories for Industrial Plant Use. *Chem. Met. Eng.*, **30**, 741 (1924). (97 ref.)

HOWE, R. M. Testing of Refractories. *Jour. Amer. Ceram. Soc.*, **6**, 296–98 (1923). (18 ref.)

LARSEN, BERNARD M., *et al.* Service Conditions of Refractories for Open-Hearth Steel Furnaces. Carnegie Inst. Tech., Mining Met. Invest., *Bull.* No. 23, 126 pp. (1925). (Bibl., pp. 120–22.)

LITINSKY, L. Literatur über feuerfeste Materialien für Eisen- und Stahlwerke. *Feuerfest*, **4**, 30–32 (1928). (138 ref.)

LITINSKY, L. Schamotte und Silica, ihre Eigenschaften, Verwendung, und Prüfung. Leipzig, Spamer, 286 pp. (1925). (Bibl., pp. 256–76.)

McDowell, J. Spotts, and Howe, R. M. Magnesite Refractories. *Jour. Amer. Ceram. Soc.*, **3**, 237–46 (1920). (Select bibl. of magnesite and magnesite brick.)

McDowell, J. Spotts, and Robertson, H. S. Chrome Refractories. *Jour. Amer. Ceram. Soc.*, **5**, 865–87 (1922). (130 ref., pp. 882–87.)

Mott, Wm. Roy. Relative Volatilities of Refractory Materials. *Trans. Amer. Electrochem. Soc.*, **34**, 282–85 (1918). (18 ref.)

National Research Council. Engineering Division. Summary of Published Material on Refractories (Other than Manufactured Ware) Used in Foundries. New York, 82 pp. (1921). (Mimeographed; contains bibls.)

Norton Co. Some References Concerning Alundum and Crystolon. *In* Refractories, Worcester, Mass. (Bibl., pp. 53–55.)

Norton, F. H. Thermal Conductivity of Some Refractories. *Jour. Amer. Ceram. Soc.*, **10**, 49–52 (1927).

Obst, Walter. (Preparation of Refractory Materials.) *Feuerfest*, **3**, 129–30 (1927). (Patent review.)

Refractories. *Feuerfest*, **3**, 105–106, 121 (1927); **4**, 98–100 (1928).

Society of Chemical Industry. Refractories. *In Repts. on Progress of Applied Chemistry*, **2**, 204–41 (1917); **3**, 184–208 (1918); **4**, 178–88 (1919); **5**, 203–15 (1920); **6**, 211–27 (1921). (Bibl. footnotes; in later volumes, combined with ceramics.)

Society of Chemical Industry. Refractories, Ceramics, and Cements. *In Repts. of Progress of Applied Chemistry*, **10**, 622–38 (1925) (65 footnotes); **11**, 217–51 (1926) (158 footnotes); **12**, 218–52 (1927) (170 footnotes); **13**, 232–50 (1928) (70 footnotes).

Steger, W. Fortschritte auf feuerfestem Gebiet in England in den Jahren 1925–1926. *Feuerfest*, **3**, 173–81, 189–94 (1927). (Bibl. footnotes.)

Watts, A. S., and King, R. M. Transfer of Heat through Refractories and Its Determination. *Jour. Amer. Ceram. Soc.*, **6**, 1075–89 (1923). (Bibl. footnotes and bibl. of 31 ref., pp. 1088–89.)

Wilkes, Gordon B. Refractory Materials. *In* International Critical Tables, Vol. II, p. 86 (1927). (89 ref.)

Roofing Tile

Thamm, J. Aus der Neueren Patent-literatur des Dachziegels. *Tonind.-Ztg.*, **51**, 1300–1302 (1927). (36 patents.)

Sand

Hopkins, L. L. Sand: Its Occurrence, Properties, and Uses; a Bibliography. Carnegie Library of Pittsburgh, 72 pp. (1918). (About 600 ref. Includes molding sands, glass sands, and filter sands.)

Stone, R. W. Sand and Gravel. U. S. Geol. Surv., *Mineral Resources*, Pt. 2, pp. 634–36 (1912). (47 ref.)

Weigel, W. M. Technology and Uses of Silica and Sands. U. S. Bur. Mines, *Bull.*, No. 266, 199 pp. (1927). (Bibl. footnotes.)

Sand-Lime Brick

Emley, Warren E. Manufacture and Properties of Sand-Lime Brick. U. S. Bur. Stand., *Tech. Paper*, No. 85, 41 pp. (1917). (50 footnotes.)

Ladoo, R. B. Sand-Lime Brick. *In* Nonmetallic Minerals, p. 519 (1926). (19 ref.)

Parr, S. W., and Ernest, T. R. Study of Sand-Lime Brick. Ill. State Geol. Surv., *Bull.*, No. 18, 83 pp. (1912). (Thesis, Univ. Ill., 1910.) (61 ref.; those references in English are reproduced in U. S. Geol. Surv., *Mineral Resources*, Pt. 2, p. 22 (1913).)

Scumming

JACKSON, F. G. Descriptive Bibliography of Scumming and Efflorescence. *Bull. Amer. Ceram. Soc.*, **4**, 376–401 (1925). (Chronological; annotated.)

REYNOLDS, M. E. Scumming and Efflorescence. *Bull. Amer. Ceram. Soc.*, **4**, 682–83 (1925). (13 ref.)

Silica: Fused

FLUSIN, G. Le verre de silice. *Chimie et ind.*, **3**, 748–49. (About 125 classified ref. on silica and silica glass.)

Silica and Silicates

AHLERS, LEONHARD. Über die Dichte von Quartz, Orthoklas, Albit, und Anorthit. *Z. Kryst.*, **59**, 293–334 (1924). (Bibl. footnotes and through text.)

ASCH, W., AND ASCH, D. The Silicates in Chemistry and Commerce. London, Constable, 476 pp. (1914). (Bibl., pp. 328–39; 780 ref.)

AUDLEY, JAMES A. Silica and the Silicates. New York, Van Nostrand, 374 pp. (1921). (Bibl. at end of chapters.)

BECHE, F. Über die Zusammenhang der physikalischen, besonders der optischen Eigenschaften mit der chemischen Zusammensetzung der Silicate. *In* Doelter, Handb. Mineralchem., Vol. 2, Pt. 1, pp. 1–26 (1914). (Bibl. footnotes.)

BOEKE, H. E. Die Methoden zur Untersuchungen des Molekularzustandes von Silikatschmelzen. *Neues Jahrb. Mineral. Geol.*, **39**, 64–78 (1914). (Bibl. footnotes.)

DOELTER, C. Allgemeines über die Synthese der Silicate. *In* Handb. Mineralchem., Vol. 1, pp. 594–618 (1912). (Bibl. footnotes.)

DOELTER, C. Die Silicatschmelzen. *In* Handb. Mineralchem., Vol. 1, pp. 628–804 (1912). (Bibl. footnotes.)

DOELTER, C. Konstitution der Silicate. *In* Handb. Mineralchem., Vol. 2, Pt. 1, pp. 61–109 (1914).

DOELTER, C., *et al.* Silicate dreiwertiger Metalle. *In* Handb. Mineralchem., Vol. 2, 1144 pp. (1917). (Bibl. footnotes.)

DOELTER, C., *et al.* Siliciumdioxyd, SiO_2. *In* Handb. Mineralchem., Vol. 2, Pt. 1, pp. 115–273 (1914). (Bibl. footnotes.)

EITEL, WILHELM. Physikalische Chemie der Silikate. Leipzig, Voss, 552 pp. (1929). (Bibl. footnotes.)

ENDELL, K., AND RIEKE, R. Über die Umwandlungen des Kieselsäureanhydrids bei höheren Temperaturen. *Z. anorg. Chem.*, **79**, 239–59 (1912). (Bibl. footnotes.)

GREEN, A. T. Consideration of the Properties of Silica and Fireclay Product in Relation to the Carbonizing Industries. *Gas Jour.*, Special No., pp. 65–77 (Feb. 14, 1928). (Discussion with an extensive list of ref. appended.)

HIMMELBAUER, A. Allgemeines über Kieselsäuren. *In* Doelter, Handb. Mineralchem., Vol. 2, Pt. 1, pp. 201–23 (1914). (Bibl. footnotes).

JACOBY, R. Siliciumdioxyd und Hydrate desselben. Silikate. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 3, Pt. 1, pp. 131–74 (1912). (Ref. through text.)

KANTER, ERHARD H. Über Erdalkalisilikate, Kieselsäure, und Alkalisilikate. Dissertation. Erlangen, 59 pp. (1902). (Bibl., pp. 55–59; 175 ref.)

KÖNIGSBERGER, J. Paragenesis der natürlichen Kieselsäuremineralien. *In* Doelter, Handb. Mineralchem., Vol. 2, Pt. 1, pp. 53–61 (1914).

KÖNIGSBERGER, J., AND MÜLLER, W. J. Beschreibung einiger synthetischer Silikatmineralien und synthetischer Versuche nebst Folgerung für das natürlichen Volkommen. *Neues Jahrb. Mineral. Geol.*, **44**, 402–59 (1920–1921).

LENHER, V., AND MERRILL, H. B. Solubility of Silica. *Jour. Amer. Chem. Soc.*, **39**, 2630–32 (1917). (32 ref.)

LITINSKY, LEONID. Schamotte und Silika: ihre Eigenschaften, Verwendung, und Prüfung. (1925) (Bibl., pp. 256–76.)

LU, KAI-CHING. Deformation Study of Various Alumino-Silicates and Borosilicates. *Jour. Amer. Ceram. Soc.*, **9**, 29–54 (1926). (34 footnotes.)

MCDOWELL, J. SPOTTS. Study of the Silica Refractories. *Trans. Amer. Inst. Mining Eng.*, **57**, 57–59 (1917). (50 ref.)

MARSHALL, ALBERT E., AND WINSHIP, W. W. Bibliography of Fused Silica. N. Y., Thermal Syndicate, 15 pp. (1915).

MAUZELIUS, ROB. Silico-Zirkoniate. *In* Doelter, Handb. Mineralchem., Vol. 3, Pt. 1, pp. 151–71 (1918). (Bibl. footnotes.)

MELLOR, J. W. The Alkali and Ammonium Silicates—Waterglass. *In* Inorg. Theor. Chem., Vol. 6, pp. 338–40 (1925). (About 250 ref.)

MELLOR, J. W. Cobalt and Nickel Silicates. *In* Inorg. Theor. Chem., Vol. 6, pp. 933–34 (1925). (40 ref.)

MELLOR, J. W. Copper, Silver, and Gold Silicates. *In* Inorg. Theor. Chem., Vol. 6, pp. 345–47 (1925). (About 175 ref.)

MELLOR, J. W. Molybdenum, Tungsten, and Uranium Silicates—Heteropoly-acids. *In* Inorg. Theor. Chem., Vol. 6, pp. 890–92 (1925). (About 250 ref.)

MELLOR, J. W. The Physical Properties of Silicon Dioxide. *In* Inorg. Theor. Chem., Vol. 6, pp. 267–74 (1925). (About 1000 ref.) Chemical properties, *ibid.*, pp. 285–88. (About 250 ref.)

MELLOR, J. W. The Preparation of Silicon Dioxide—Quartz, Tridymite, and Cristobalite. *In* Inorg. Theor. Chem., Vol. 6, pp. 243–45 (1925). (About 150 ref.)

MELLOR, J. W. Silicates of the Alkaline Earths. *In* Inorg. Theor. Chem., Vol. 6, pp. 373–80 (1925). (About 1000 ref.)

MELLOR, J. W. Silicates and Aluminosilicates. *In* Inorg. Theor. Chem., Vol. 6, pp. 315–17 (1925). (About 150 ref.)

MELLOR, J. W. Silicates of the Phosphorus Family. *In* Inorg. Theor. Chem., Vol. 6, p. 839 (1925). (About 40 ref.)

MELLOR, J. W. Silicates of the Titanium Lead Family. *In* Inorg. Theor. Chem., Vol. 6, pp. 859–65 (1925). (About 750 ref.)

MELLOR, J. W. Silicon Suboxides and Oxyhydrides–Siloxanes. *In* Inorg. Theor. Chem., Vol. 6, pp. 236–37 (1925). (About 30 ref.)

MELLOR, J. W. Zinc, Cadmium, and Mercury Silicates. *In* Inorg. Theor. Chem., Vol. 6, pp. 445–57 (1925). (About 250 ref.)

MOREY, G. W., AND NIGGLI, PAUL. Hydrothermal Formation of Silicates. *Jour. Amer. Chem. Soc.*, **35**, 1105–30 (1913); *Z. anorg. Chem.*, **83**, 391–415 (1913). (81 ref., annotated; chronological (1845–1913) with tabular summary by minerals.)

PECK, ALBERT H. Changes in the Constitution and Microstructure of Andalusite, Cyanite, and Sillimanite at High Temperatures and Their Significance in Industrial Practice. *Jour. Amer. Ceram. Soc.*, **8**, 428–29 (1925). (22 ref.)

PONOMAREV, I. F. Synopsis of Literature Concerning the Chemical Combination of Silica. *Trans. State Exptl. Inst. Silicates* [U.S.S.R.], **9**, 1–91 (1924). (Review for years 1912–1913.)

REITER, H. H. Experimentelle Studien an Silikatschmelzen. *Neues Jahrb. Mineral. Geol.*, **22**, 260–64 (1906). (94 ref., covering years 1879–1906.)

RIEKE, REINHOLD. Die Arbeitsmethoden der Silikatchemie. Braunschweig, Vieweg, 1917. (Bibl., pp. 92–98.)

SOSMAN, ROBERT B. Electrical and Optical Properties of Silica. International Critical Tables, Vol. VI, 344 pp. (1929). (94 ref.)

SOSMAN, ROBERT B. Mechanical and Thermal Properties of the Various Forms of Silica. International Critical Tables, Vol. IV, 22 pp. (1928). (81 ref.)

SOSMAN, ROBERT B. Properties of Silica; An Introduction to the Properties of Substances in the Solid Nonconducting State. N. Y., Chem. Cat. Co., 856 pp. (1927). (Bibl. footnotes.)

VAIL, JAMES G. Silicate Solutions and Siliceous Gels. *Jour. Soc. Chem. Ind.*, **44**, 214–19T (1925). (59 footnotes.)

ZAMBONINI. Silicotitanate. *In* Doelter, Handb. Mineralchem., Vol. 3, Pt. 1, pp. 54–71 (1918). (Bibl. footnotes.)

Silicates: Analysis

DITTRICH, M. Analytische Methoden der Silicate. *In* Doelter, Handb. Mineralchem., Vol. 1, pp. 560–94 (1912). (Bibl. footnotes.)

HILLEBRAND, W. F. Analysis of Silicate and Carbonate Rocks. U. S. Geol. Surv., *Bull.*, No. 700, 285 pp. (1919). (Bibl. footnotes.)

Silicon Carbide

HÖNIGSCHMID, O. Siliciumcarbid. *In* Doelter, Handb. Mineralchem., Vol. 1, pp. 552–56 (1912). (15 footnotes.)

JACOBY, R. Siliciumcarbide. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 3, Pt. 1, pp. 211–13 (1912).

Sodium Borate

EPHRAIM, FRITZ. Borsaures Natrium. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 2, Pt. 1, pp. 415–23 (1906).

Sodium Borate. Ind.-Cat. S. G. O., 2nd Ser., No. 16, p. 139 (1911).

Sodium Silicate

DOELTER, C. Natrium-Aluminiummetasilicat. *In* Handb. Mineralchem., Vol. 2 Pt. 2, pp. 208–28, pp. 343–408 (1917). (Bibl. footnotes.)

DOELTER, C. Natriumferrimetasilicat. *In* Handb. Mineralchem., Vol. 2, Pt. 2, pp. 333–43 (1917). (Bibl. footnotes.)

DOELTER, C., *et al.* Chlor- und schwefelhältige Natrium-Aluminiumsilicate. *In* Handb. Mineralchem., Vol. 2, Pt. 2, pp. 229–333 (1917). (Bibl. footnotes.)

DOELTER, C., AND MICHEL, H. Mischungen von Natriumaluminiumsilicaten mit Calciumaluminiumsilicaten. *In* Doelter, Handb. Mineralchem., Vol. 2, Pt. 3, pp. 217–315 (1921). (Bibl. footnotes.)

JACOBY, R. Natriumaluminiumsilikate. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 3, Pt. 1, pp. 273–82, pp. 1303–1306 (1912).

JACOBY, R. Natriumsilikate. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 3, Pt. 1, pp. 227–37 (1912).

MICHEL, H. Natronanorthit-Carnegieit. *In* Doelter, Handb. Mineralchem., Vol. 2, Pt. 3, pp. 290–312 (1921). (Bibl. footnotes.)

SCHRERO, NORRIS. Water Glass, A Bibliography. Carnegie Library, Pittsburgh, 87 pp. (1922). (Classified under history, general, properties, manufacture, application, analysis.)

WAESER, B. Kieselsäure und Alkalisilicate. *In* Bräuer und d'Ans, Fortschritte, Vol. 1, p. 2548 (1922). (German patents.)

Specific Heat

AWBERY, J. H., AND BARNES, H. T. Heat Capacity of Chemical Compounds in the Crystalline and Liquid States. International Critical Tables, Vol. V, pp. 116–17 (1929). (324 ref.)

CLARKE, FRANK W. A Table of Specific Heats for Solids and Liquids. Constants of Nature, Pt. II. Smithsonian Misc. Coll., No. 276, 57 pp. (1876). (Bibl., pp. 5–7; 46 ref.)

EITEL, W. Das Nernst'sche Wärmetheorem und seine Bedeutung für mineralogisch-geologische Probleme. Fortschritte Mineral., *Krist. Petr.*, **8,** 62–68 (1923).

EUCKEN, A. Der Nernstsche Wärmeersätz. Ergebnisse der exakten, *Naturwissenschaften*, **1,** 162 (1922). (35 ref.)

EUCKEN, A. Neuere Untersuchungen über den Temperaturverlauf der spezifischen Wärme. *Jahrb. Radioakt. Elektronik*, **8,** 489–93 (1911). (77 ref.)

LANDOLT-BÖRNSTEIN. Spezifische Wärme. *In* Tabellen, 4th ed., pp. 777–85 (1912); 5th ed., pp. 1281–88 (1923).

MELLOR, J. W. Specific Heats of Elementary Solids. Dulong and Petit's rule. *In* Inorg. Theor. Chem., Vol. 1, pp. 798–805 (1922). (100 ref.)

MURAOUR, H. La variation de la chaleur spécifique des gaz avec la température d'après les travaux les plus récents. *Chimie & Industrie*, **10,** 29 (1923). (50 ref.)

SCHULZ, KARL. Die spezifische Wärme der Mineralen und der künstlich hergestellten Stoffe von entsprechender Zusammensetzung. *Fortschritte Mineral. Krist. Petr.*, **2,** 259–304 (1912); **3,** 273–320 (1913). (109 ref.)

Tables Annuelles. Chaleur spécifique., **1,** 50–59 (1910); **2,** 43–50 (1911); **3,** 51–56 (1912); **4,** 139–52 (1916); **5,** 74–83 (1917–1922); **6,** 78–83 (1923–1926). (Ref. to all numerical data reported during those years.)

WIGAND, ALBERT. Neuere Untersuchungen über spezifische Wärmen. *Jahrb. Radioakt. Elektronik*, **10,** 54–59 (1913). (88 ref.)

Stannic Oxide

HENGLEIN, M. Zinnoxyd (SnO_2). *In* Doelter, Handb. Mineralchem., Vol. 3, Pt. 1, pp. 177–89 (1918). (Bibl. footnotes.)

MELLOR, J. W. Stannous Oxide and Hydroxide. Stannic Oxide. The Stannic Hydroxides. The Stannates. *In* Inorg. Theor. Chem., Vol. 7, pp. 393–94, 401–404, 413–14, 421 (1927). (About 750 ref.)

SCHLENK, O. Stannioxyd. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 4, Pt. 1, pp. 271–85, pp. 977–80 (1911).

Terra Cotta

WILSON, HEWITT. Terra Cotta. *Bull. Amer. Ceram. Soc.*, **5,** 137–45 (1926). (173 ref.; classified.)

See also Ceramics.

Thermal Expansion

CLARK, J. S. Thermal Expansion Including Volume Change on Fusion, Solidification, and Tempering. International Critical Tables, Vol. II, pp. 477–78 (1927). (143 ref.)

Coefficients de Dilatation. *In* Tables annuelles, Vol. I, pp. 44–48 (1910); Vol. II, pp. 38–42 (1911); Vol. III, pp. 49–50 (1912); Vol. IV, pp. 133–38 (1913–1916); Vol. V, pp. 10–19 (1917–1922); Vol. VI, pp. 19–24 (1923–1926).

Titanates

MELLOR, J. W. The Titanates. *In* Inorg. Theor. Chem., Vol. 7, pp. 60–63 (1927). (350 ref.)

Titanium Fluorides

MELLOR, J. W. Titanium Fluorides. *In* Inorg. Theor. Chem., Vol. 7, p. 69 (1927). (40 ref.)

Titanium Oxides

MELLOR, J. W. The Titanium Oxides and Hydroxides. *In* Inorg. Theor. Chem., Vol. 7, pp. 44–49 (1927). (600 ref.)

Tridymite

DOELTER, C. Tridymit. *In* Handb. Mineralchem., Vol. 2, Pt. 1, pp. 190–98 (1914). (Bibl. footnotes.)

JACOBY, R. Tridymit. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 3, Pt. 1, p. 135 (1912).

Vanadates

MELLOR, J. W. The Vanadates of the Alkaline Earths. *In* Inorg. Theor. Chem., Vol. 9, p. 772 (1929). (About 30 ref.)

MELLOR, J. W. The Vanadates of the Aluminium and Lead Families. *In* Inorg. Theor. Chem., Vol. 9, pp. 778–89 (1929). (About 150 ref.)

MELLOR, J. W. The Vanadates of Ammonium and the Alkalis. *In* Inorg. Theor. Chem., Vol. 9, p. 766 (1929). (About 60 ref.)

MELLOR, J. W. Vanadates of the Bismuth and Chromium Families. *In* Inorg. Theor. Chem., Vol. 9, pp. 789–90 (1929). (About 150 ref.)

MELLOR, J. W. The Vanadates of the Copper Family. *In* Inorg. Theor. Chem., Vol. 9, p. 768 (1929). (About 35 ref.)

MELLOR, J. W. Vanadates of the Magnesium Family. *In* Inorg. Theor. Chem., Vol. 9, pp. 774–75 (1929). (About 40 ref.)

MELLOR, J. W. The Vanadates of the Manganese and Iron Families. *In* Inorg. Theor. Chem., Vol. 9, p. 792 (1929). (20 ref.)

Vanadium

MELLOR, J. W. Vanadium. *In* Inorg. Theor. Chem., Vol. 9, pp. 714–39 (1929); (history, 40; occurrence, 300; extraction, 175; properties, 300; atomic weights, 50 ref.).

Vanadium Oxides

DUMANSKI, A. Das Hydrosol des Vanadinpentoxyds. *Kolloid-Z.*, **33**, 147–59 (1923). (35 footnotes.)

FREUNDLICH, H., STAPELFELDT, F., AND ZOCHER, H. Quantitative Untersuchungen am Vanadinpentoxydsol. I. Die Strömungsanisotropie. *Z. physik. Chem.*, **114**, 161–89 (1924–1925). (Bibl. footnotes.)

GESSNER, HERMANN. Über einige Alterungserscheinungen an Vanadinpentoxyd-Solen. *Kolloidchem. Beihefte*, **19**, 213–97 (1924). (Bibl. footnotes.)

MELLOR, J. W. Vanadium Hemioxide, Dioxide, and Trioxide. *In* Inorg. Theor. Chem., Vol. 9, pp. 742–43 (1929). (About 100 ref.)

MELLOR, J. W. Vanadium Pentoxide. *In* Inorg. Theor. Chem., Vol. 9, pp. 755–57 (1929). (About 300 ref.)

MELLOR, J. W. Vanadium Tetroxide and the Hypovanadates. *In* Inorg. Theor. Chem., Vol. 9, pp. 747–48 (1929). (About 40 ref.)

PRANDTL, W. Vanadin und Sauerstoff. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. 3, Pt. 2, pp. 73–92 (1908).

Zeolites

RINNE, F. Kristallographische-chemischer Ab- und Umbau inbesonders von Zeoliten. *Fortschritte Mineral. Kryst. Petrog.*, **3**, 181–83 (1913). (55 ref.)

SCURTI, F. Per la conoscenza del terreno agrario. Le zeolite naturali. *Ann. chim. appl.*, **13**, 161–93 (1923). (73 footnotes.)

STOKLOSSA, GEORG. Über die Natur des Wassers in den Zeoliten. *Neues Jahrb. Mineral. Geol.*, **42**, 1–64 (1918–1919). (Ref. to analyses through text.)

Zirconium

ANDRIEUX, L. La zircone et le zirconium. *Industrie chimique*, **8**, 480–81 (1922). (21 ref.)

CAVEN, ROBERT M. Zirconium. *In* Friend, Textbook, Vol. 5, pp. 260–76 (1917). (Bibl. footnotes.)

CLEVE, P. T. Le zirconium et ses composés. *In* Frémy, Enc. chim., Vol. 3, (5e cahier), pp. 52–53 (1884).

HALEN, S. Die Verwendung des Zirkons und seiner Verbindungen. *Edel-Erden-Erze*, **1**, 121–24, 134–36, 149 (1920). (Ref. through text.)

HALEN, S. Die neuesten Arbeiten und Erfindungen betreffend Zirkonium und seiner Verbindungen. *Edel-Erden-Erze*, **2**, 81–83 (1921). (Ref. through text; covers period of 5 years.)

JACOBY, R. Zirkonium. *In* Gmelin-Kraut, Handb. anorg. Chem., Vol. VI, Pt. 1, pp. 1–67, 648–784 (1928). (Bibl. through text.)

LANGMUIR, A. C., AND BASKERVILLE, C. Index to the Literature of Zirconium, 1789–1899. Smithsonian Misc. Coll., Pub., No. 1173, 29 pp. (1899). (248 ref., with author and subject index.)

MARDEN, J. W., AND RICH, M. N. Investigations of Zirconium with Special Reference to the Metal and Oxide. Historical Review and Bibliography. U. S. Bur. Mines, *Bull.*, No. 186, 146 pp. (1921). (Bibl., pp. 119–44; 443 ref., classified according to the mineral, salts, analytical, metal, and alloys.)

MELLOR, J. W. Zirconium. *In* Inorg. Theor. Chem., Vol. 7, pp. 98–165 (1927). (History, 40; occurrence, 40; extraction, 130; preparation, 60; physical properties, 120; chemical properties, 270; ref. to salts throughout text.)

MEYER, R. J. Zirkonium. *In* Abegg, Handb. anorg. Chem., Vol. 3, Pt. 2, pp. 517–22 (1909). (169 ref., covering years 1789–1909.)

SCHALLER, W. T. Thorium, Zirconium, and Rare Earth Minerals. U. S. Geol. Surv., *Mineral Resources*, Pt. 2, 386 pp. (1916) (14 ref.); Pt. 2, 31 pp. (1919) (17 ref.).

STERRETT, D. B. Monazite and Zircon. U. S. Geol. Surv., *Mineral Resources*, Pt. 2, 1196 pp. (1911). (22 ref.)

VENABLE, FRANCIS P. Zirconium and Its Compounds. N. Y., Chem. Cat. Co., 173 pp. (1922). (Bibl., pp. 133–69; 100 patents and 831 literature ref.)

VIGOUROUX, EM. Zirconium. *In* Moissan, Chim. min., Vol. 2, pp. 530–59 (1905). (162 footnotes.)

WEDEKIND, E. Studien über das elementare Zirkonium. *Ann.*, Vol. 395, pp. 149–94 (1913). (Bibl. footnotes.)

Zirconium Oxides

MELLOR, J. W. The Zirconium Oxides. *In* Inorg. Theor. Chem., Vol. 7, pp. 132–34 (1927). (300 ref.)

ACTIVITIES OF THE SOCIETY

REPORT OF COMMITTEE ON RULES CONCERNING FELLOWS

Office of the Chairman of the Fellows
1445 Summit Street
Columbus, Ohio
May 7, 1931

To Members of the Fellows:

Please note that the Committee appointed in Cleveland on February 25, 1931, consisting of E. Ward Tillotson, A. V. Bleininger, and Alexander Silverman, to whom was entrusted consideration of the proper set of letters to be used by a Fellow after his name, adopted the following report. As the Committee was appointed with power to act, its decision is final.

The recommendation of the Committee is as follows:

That Article 2, Paragraph 6, of the Rules be amended so that the last sentence shall read: Persons elected Fellows shall be entitled to use the initials F.A.C.S. after their names as the symbol of Fellowship, if they so desire.

Inasmuch as this action will become binding only when the Rules of the SOCIETY have been amended in proper form, this information is given to all Fellows in order that they may avoid any mistake by using the old symbol as at present provided in the Rules.

EDWARD ORTON, JR., *Chairman of the Fellows*

CONSTITUTION AND BY-LAWS OF THE AMERICAN CERAMIC SOCIETY

Constitution

Article I

(1) This SOCIETY shall be known as THE AMERICAN CERAMIC SOCIETY.

(2) The object of the SOCIETY is to advance the ceramic arts and sciences by meetings for the reading and discussion of papers, the publication of scientific literature, and other activities.

Article II

Membership

(1) The SOCIETY shall consist of Honorary Members, *Ex-Officio* Honorary Members, Fellows, Active Members, Life Members, Associate Members, Corporation Members, Life Corporation Members, and Industrial Association Members.

(2) Honorary Members must be persons of professional eminence, elected in recognition of their achievements in ceramic art or science. Their number shall not exceed ten.

(3) Honorary Members shall be nominated by at least ten Active Members and unanimously approved by the Board of Trustees. Such nominations shall be placed before the SOCIETY at an annual meeting, and must receive the affirmative vote of at least 90% of those voting, by letter ballot, at the next succeeding annual election.

(4) *Ex-Officio* Honorary Members must be such officers of such other associations and societies as shall be unanimously designated by the Board of Trustees, the name of the person holding such office appearing on the SOCIETY roster as *Ex-Officio* Honorary Member during the term of his incumbency only.

(5) Fellows shall compose a group of Active Members upon whom this title is conferred in recognition of their contributions to Ceramic Arts and Science. Active Members to be eligible to be elected Fellows must have been enrolled as Active Members not less than five years, and must have won recognition in the SOCIETY by high professional ideals, sustained interest in and devotion to the objects of the SOCIETY, broad and productive scholarship in Ceramic Science, or outstanding achievement in some branch of the Ceramic Arts. The methods to be used in determining the eligibility of a candidate shall be devised and administered by the Fellows.

(6) Fellows shall be nominated by at least seven Active Members in the Division in which their major interest lies. Upon nomination the candidate's name, his qualifications, and the list of his publications and achievements in the Ceramic Arts shall be submitted to a jury of nine Fellows, to be known as the Fellowship Jury, which shall pass upon the nomination, and if they approve it by a vote of not less than seven affirmative votes, it shall then be certified to the Board of Trustees. If the Fellowship Jury shall fail to approve the nomination by the required vote, the candidate shall be so notified with a statement of the reasons for the action, but nothing in this action shall prevent a renewal of the nomination upon the lapse of not less than one year, in which case it shall be considered again as in the first instance. Any nomination which has been certified by the Fellowship Jury shall be considered by the Board of Trustees and if approved by a vote of not less than four-fifths of the Board, then the nominee shall be declared elected, and shall be publicly inducted into the Fellowship grade at the next convenient occasion, without ballot by the SOCIETY, and shall be presented with a suitable certificate of election by the SOCIETY. Persons elected Fellows shall be entitled to use the initials F.A.C.S. after their names, as a symbol of Fellowship, if they so desire.

(7) Active Members are Associate Members who have been enrolled twenty-four months. This change in grade occurs automatically.

(8) Life Members must be those members, Active or Associate, who make single payment of an endowment fee as prescribed in Article III. Life Members shall have the same rights as Active Members.

(9) Associate Members must be persons interested in the ceramic or allied industries.

(10) Corporation Members must be persons, firms, or corporations who, being interested in the SOCIETY, make such financial contributions for its support as are prescribed in Article III. Their membership shall become operative on payment of dues as prescribed in Article III.

(11) Life Corporation Members must be persons, firms, or corporations who make single payment of an endowment fee as prescribed in Article III. Life Corporation Members shall have the same rights as Corporation Members.

(12) Industrial Association Members must be organized groups of manufacturers, who being interested in the advancement of ceramic arts and sciences shall make, for this purpose, such financial contributions as are prescribed in Article III.

(13) All Honorary Members, *Ex-Officio* Honorary Members, Fellows, Active Members, Life Members, Associate Members, Corporation Members, Life Corporation Members, and Industrial Association Members, shall be equally entitled to the privileges of membership, except that only Fellows, Active Members, Life Members, one representative of each Corporation Member, and one representative of each Life Corporation Member shall be entitled to vote. Such representative shall be officially designated by the person, firm, or corporation represented. Only Fellows, Active Members, and Life Members shall be entitled to hold office. The Roster of each grade of membership shall be printed separately in at least one publication issued by the SOCIETY annually.

(14) Any person may be expelled from any grade of membership of the SOCIETY if written charges, signed by five or more Fellows, Active Members, or Life Members be

filed against him or her, and if said charges are considered and acted upon as set forth in Article VII, Section 4. In case of such expulsion, any moneys paid the SOCIETY as endowment fees become forfeit to the SOCIETY and automatically become a part of the Research Fund.

Article III

Dues

(1) Honorary and Ex-Officio Honorary Members shall be exempt from all fees and dues.

(2) The annual dues for Fellows shall be fixed by the Board of Trustees but shall not exceed seventeen and one-half dollars, six of which shall be a subscription to the *Journal of the American Ceramic Society*.

(3) The annual dues for Active and Associate Members shall be fixed by the Board of Trustees but shall not exceed twelve and one-half dollars, six of which shall be a subscription to the *Journal of the American Ceramic Society*.

(4) Life Members shall pay a single endowment fee of $200.00, the interest earnings from which shall be used during the life of the member for current expenses. Upon the death of the member, the interest shall be used under the direction of the Board of Trustees for ceramic research. The privileges of membership shall begin upon payment of this fee.

(5) Corporation Members shall pay such annual dues as are fixed by the Board of Trustees but these shall not be less than twenty-five dollars, six dollars of which shall be a subscription to the *Journal of the American Ceramic Society*. The privileges of membership shall begin upon payment of the annual dues.

(6) Life Corporation Members shall pay a single endowment fee of $600.00, the interest earnings from which shall be used for current expenses for a period of twenty-five years after which time the interest shall be used under the direction of the Board of Trustees for ceramic research. The privileges of membership shall begin upon payment of this fee.

(7) Industrial Association Members shall pay such annual dues in monthly instalments or single payment as shall be agreed upon by the Association and the Board of Trustees, but such dues shall not be less than $480.00 annually.

Article IV

Officers

(1) The affairs of the SOCIETY shall be managed by a Board of Trustees, consisting of the President, Vice-President, Treasurer, the two most recent Past Presidents, and one Trustee representative of each of the Divisions. The President, Vice-President, and Treasurer shall be elected to serve one year. Each Trustee shall be elected to serve three years.

(2) The President shall have general supervision of the affairs of the SOCIETY under the direction of the Board of Trustees of which he shall act as chairman and shall perform such other duties as pertain to his office.

(3) He shall countersign the checks drawn by the Treasurer when such drafts are known by him to be proper and duly authorized by the Board of Trustees.

(4) The Vice-President will preside at all meetings in the absence of the President. If the office of President should become vacant the Vice-President shall be vested with all the powers and required to perform all the duties of that office until a new President has been duly appointed by the Board of Trustees.

(5) A Secretary shall be appointed by the Board of Trustees for a term of not more than two years.

(6) The Secretary shall see that all moneys due the SOCIETY are collected and transferred to the custody of the Treasurer. He shall carefully scrutinize all expenditures and use his best endeavors to secure economy in the administration of the SOCIETY. He shall personally investigate and certify the accuracy of all bills or vouchers on which money is to be paid. He shall have charge of the books of accounts of the SOCIETY and shall furnish monthly to the Board of Trustees a statement of monthly balances. He shall present annually to the Board of Trustees a balance sheet of his books as of the 31st of December and shall furnish from time to time such other statements as may be required of him.

(7) The Secretary shall conduct the correspondence of the SOCIETY and keep full record of the same. He shall transmit promptly to the Board of Trustees for their consideration all communications not of routine nature. He shall cause to be published in the *Journal* the results of all balloting on the business of the SOCIETY unless otherwise ordered by the Board of Trustees. He shall perform all other duties which may from time to time be assigned to him by the Board of Trustees.

(8) The Secretary may be paid a salary to be determined by the Board of Trustees.

(9) The Secretary shall furnish a suitable bond for the satisfactory performance of his duties, which shall be held in the custody of the President.

(10) The Treasurer shall receive all moneys due the SOCIETY and deposit the same in the name of the SOCIETY in a national bank designated by the Treasurer and approved by the Board of Trustees. He shall invest all funds not needed for current disbursements, as shall be ordered by the Board of Trustees. He shall pay all bills by draft, when certified by the Secretary or as ordered by the Board of Trustees. He shall furnish a satisfactory bond for the proper performance of his duties, which shall be held in the custody of the President.

(11) All securities belonging to the SOCIETY shall be held in the custody of the Treasurer.

(12) The accounts of the Secretary and of the Treasurer shall be audited before each Annual Meeting by a certified public accountant or some other competent person designated by the Board of Trustees.

(13) A vacancy in any office shall be filled by appointment by the Board of Trustees, but the new incumbent shall not thereby be rendered ineligible for reëlection to the same office at the next Annual Meeting. On the failure of any officer or any member of a committee to execute his duties within a reasonable time, the Board of Trustees, after duly warning such person, may declare the office vacant and appoint a new incumbent.

(14) A majority of the Board of Trustees shall constitute a quorum, but the Board of Trustees shall be permitted to carry on such business as it may desire by letter.

Article V
Nominations and Elections

(1) There shall be two nominating committees selected at each Annual Meeting. Such committees will each consist of one member from each Division of the SOCIETY and each will prepare an independent ticket of nominations to be submitted to the SOCIETY for ballot. The members of the Nominating Committees will be selected as follows: At the final session of each Division two members of that Division will be elected to the Nominating Committee. These two will draw to determine which shall be on Committee No. 1 and which on Committee No. 2. The names and designations of these elected members of each Division will be immediately reported to the Secretary by the chairman or acting chairman of each Division.

Each Nominating Committee will be notified of its membership by the Secretary and each Committee will at once appoint its own chairman and proceed to the nomination of officers for the ensuing year.

There are no restrictions as to the make-up of the two tickets and the same or different names may appear upon the two slates.

(2) Nominations for President, Vice-President, and Treasurer. The Nominating Committees shall, by majority letter vote, select nominees for President, Vice-President, and Treasurer.

(3) Election. The names of all nominees for offices mentioned in the preceding paragraph of this article, provided their assent has been obtained before nomination, shall be placed upon a printed ballot in alphabetical order and shall be mailed to each voting member not in arrears at least twenty days before the Annual Meeting. The voting shall be confined to the names appearing on this ballot. The ballot shall be inclosed in an envelope on which there shall be no mark of identification other than the word "Ballot." The envelope shall be enclosed in another envelope for mailing, addressed to the Secretary, upon the back of which the voter shall endorse his name.

The envelopes and ballots shall be opened in the presence of three scrutineers appointed by the President, who will report the result of the election at the Annual Meeting.

A plurality of affirmative votes cast shall elect.

(4) Election of Trustees. Each division, by plurality letter vote of its major members, shall elect a trustee to serve for a period of three years according to the schedule provided in Section X of the By-Laws, the names of the Trustees thus chosen by the Division shall be certified to the Secretary of the SOCIETY not later than December 31 of each year.

Article VI

Committees

(1) Except as otherwise provided the following Standing Committees shall be appointed annually by the Board of Trustees:

1. Rules
2. Publications
3. Membership
4. Standards
5. Sections and Divisions
6. Papers and Programs
7. Research
8. Geological Survey
9. Data
10. Ceramic Education
11. A Coördinating Service Council

Except as otherwise provided the chairman of each committee shall be appointed by the Board of Trustees.

(2) The Committee on Rules shall consist of the Chairmen of the Rules Committees of the Divisions having such committees. It shall receive all recommendations relating to changes of Constitution and By-Laws and shall report upon the same to the Secretary for transmission to the SOCIETY. It shall have power to propose changes in the Rules of the SOCIETY.

(3) The Committee on Publications shall consist of the Editor and four members. The duties of the Editor and Committee on Publications are defined under Article X on Publications.

(4) The Committee on Membership shall consist of the Chairmen of Membership Committees of the Divisions having such committees, and shall have power to appoint subcommittees. Its function shall be to undertake systematically the enlargement of the membership of the SOCIETY among those interested in the ceramic and allied industries.

(5) The Committee on Standards shall consist of a chairman and subcommittees as follows:

Subcommittee A, on Definitions, consisting of three members appointed by the Board of Trustees.

Subcommittee B, on Raw Material Specifications, consisting of three members appointed by the Board of Trustees.

Subcommittee C, on Standardization of Tests, consisting of one member selected by each Division.

Subcommittee D, on Standardization of Products, consisting of one member selected by each Division.

(6) The Divisional Standardization Committees shall be selected by their respective Divisions. Their function shall be the preparation of tests and specifications for the materials and products of their respective branches of the ceramic industry. Each shall be responsible to its Division, but all reports, resolutions, or recommendations that are to be printed or generally distributed shall be approved by the Committee on Standards before publication.

(7) The function of the Committee on Standards shall be to prepare or have prepared tests and specifications for ceramic materials and products and to submit to the Board of Trustees written reports, resolutions, and recommendations relating thereto. The Committee may report at any regular meeting of the SOCIETY. For adoption, these reports, resolutions, and recommendations must be submitted in printed form to the members of the SOCIETY at least six months before a vote may be taken, during which time any amendments, changes, or corrections, suggested by any member may, with the approval of the Committee, be incorporated. The reports, resolutions, and recommendations as amended shall then be submitted by letter ballot to the voting members. A two-thirds vote shall be required for adoption and the polls shall close sixty days after distribution of the ballot.

(8) The Committee on Sections and Divisions shall consist of five members in addition to the Chairmen of the Divisions. Its duties shall be to promote the organization and welfare of Local Sections, Student Branches, and Divisions.

(9) The Committee on Papers and Programs shall consist of the Secretaries of the Divisions, the Secretary of the SOCIETY, and such other persons as the Board of Trustees may deem advisable. Its duties shall be to procure papers and discussions for the meetings and publications of the SOCIETY. The Committee may require an abstract of any paper submitted before placing it upon a program.

(10) The Committee on Research shall consist of one member selected by each Division. Its duties shall be to organize and encourage scientific investigations pertaining to the ceramic and related industries, especially those investigations which will stimulate the development of our national industries and resources. It shall be empowered to coöperate with similar committees of other scientific societies and with Government bureaus.

(11) The Committee on Geological Surveys will coöperate with national and state geological surveys and associations in planning laboratory and plant investigations instituted by them, and interpreting data. This Committee shall consist of a chairman and four members appointed by the Board,

(12) The Committee on Data shall arrange symposiums and prepare for publication monographs, bibliographies, statistics, etc. This Committee shall consist of one member selected by each Division.

(13) The Committee on Ceramic Education shall consist of one representative selected by each Division. This Committee shall make recommendations through the Board of Trustees for the betterment of ceramic education in institutions now established and for the encouragement of new departments of ceramics where the demand and facilities warrant.

(14) The Coördinating Service Council shall consist of the General Secretary, *Ex-Officio* Chairman, and the Chairmen of the Committees on Research, Standards, Geologi-

cal Surveys, Data, and Ceramic Education. The Council shall have general supervision of the work of these Committees, for the purpose of coördinating other organizations on ceramic topics and problems.

Article VII
Fellows

(1) The grade of Fellowship, being conferred upon Active Members as a distinction in recognition of meritorious service and comprising members from all Divisions, shall not in itself confer upon its recipients any powers, rights, or duties different from those common to Active Members or Life Members, except as set forth hereinafter.

(2) The Fellows shall be charged with the consideration of all legislation emanating from Committees, which have a bearing upon the general policies of the SOCIETY outside of the special field of the Committee proposing the legislation, or recommendations from Divisions which have a bearing upon the activities of other Divisions than the one proposing the recommendation. Upon such legislation or recommendation being offered, it shall be referred by the President to the Fellows for their consideration, and upon return of such legislation or recommendation with their approval, then the Board of Trustees shall pass upon such legislation or recommendation by the vote of the majority. In event of the return of such legislation or recommendation with the disapproval of the Fellows, then the Board of Trustees shall not pass the same, except upon the affirmative vote of not less than four-fifths of the members of the Board.

(3) The Fellows shall be especially charged with the consideration of all questions of professional ethics and the formulation from time to time of Codes of Ethics for Ceramic Engineers, and others dealing with the subject matter of Ceramics in a professional capacity.

(4) In event of the filing of written charges against any member of the SOCIETY, as provided in Article II, Section 14, the matter shall be dealt with by a Committee of Fellows appointed by the Fellows for such purpose. Such person, however, shall be notified of the charges and of the date at which said charges will be considered, and given a reasonable time to appear before the Committee, either in person, or by counsel or both, or to present a written defense. The Committee shall then file a written report of its findings and its recommendation thereon with the Board of Trustees. The Board of Trustees may accept the recommendation of the Committee by majority vote, or may disapprove such recommendation by negative vote of not less than four-fifths of the Board. The decision of the Board shall be final.

(5) The Fellows shall have the right and the duty to consider from time to time any matter of general policy affecting the professional aspects of the work of the SOCIETY or of its relations to other professional societies, and to initiate such legislation relating thereto as it shall deem proper or necessary. Any such recommendations or legislation shall be referred to the Board of Trustees for action. The Board of Trustees may approve such action by majority vote or may disapprove such action by a four-fifths vote, or upon request of one or more of the Divisions, the Board shall publish the proposed action and place the final adoption of the same upon the affirmative vote of the majority of the SOCIETY present at an Annual Meeting or upon a two-thirds affirmative vote of those voting by letter ballot at the next annual election.

(6) The Board of Trustees may at any time refer to the Fellows any matter upon which they desire their opinion.

(7) The affairs of the Fellows shall be managed by a Chairman, a Secretary-Treasurer, and such other officers as they deem necessary. The officers shall be elected annually by ballot at the last session of the Fellows held during an Annual Meeting of the SOCIETY and shall take office at the close of the meeting at which they are elected. The officers shall hold office for one year or until their successors are elected.

(8) There shall be held one or more meetings of the Fellows at each Annual Meeting of the SOCIETY, at such time and place as may be agreed upon, and the Secretary of the SOCIETY shall make provision for such meetings and place them upon the printed program of the Annual Meeting of the SOCIETY. The Fellows may hold such other meetings as they deem necessary for their work. The Fellows, as such, shall not have representatives upon the Divisions or upon the standing Committees of the SOCIETY.

(9) The Fellows shall have power to make their own rules and by-laws for the conduct of their business as they deem proper, except that they shall not adopt any rule or by-law which conflicts with the Constitution and By-Laws of the SOCIETY as a whole.

(10) The Board of Trustees shall make provision for the necessary expenses of the Fellows from the general funds of the SOCIETY.

Article VIII

Divisions

(1) Groups to be known as Divisions of the SOCIETY and to be organized from members of the SOCIETY may be authorized by the Board of Trustees for stimulating the growth and development of the SOCIETY when such action shall seem wise and expedient. Only bona fide members of the SOCIETY are entitled to affiliate with and participate in the activities of such Divisions, but Divisions which, prior to August, 1920, have enrolled persons who are not members of the SOCIETY, may retain such persons as members of the Division. A member of the SOCIETY may enroll in any Division in which he is interested but for the purpose of nominating for Division representative on the Board of Trustees each member must declare one and only one Division as his major Division, and he shall be designated as a major member of that Division.

(2) The affairs of a Division shall be managed by a Chairman, a Secretary-Treasurer, and such other officers as the Division may deem necessary. The officers of the Division shall be elected annually by ballot at the last session of the Division held during the Annual Meeting of the SOCIETY and shall take office at the close of the meeting at which they are elected. All members of a Division are entitled to vote. The officers shall hold office for one year or until their successors are elected.

(3) Representatives of Divisions upon Committees of the SOCIETY shall be as indicated in Article VI.

(4) Divisions shall have power to make their own rules and by-laws except that they shall not adopt any rule or by-law which conflicts with the Constitution and By-Laws of the SOCIETY as a whole.

Article IX

Local Sections

(1) Local Sections, each carrying some distinguishing title prefixed to the words "Section of the AMERICAN CERAMIC SOCIETY," may be authorized by the SOCIETY.

(2) The purposes of such Sections shall be to strengthen and extend the work of the SOCIETY, as defined in Article I of the Constitution, by more frequent meetings in local centers than are possible to the SOCIETY as a whole, and by bringing the benefits of the work to persons who would not otherwise be reached.

(3) Application for permission to form a Local Section must be in writing and signed by not less than ten members of the SOCIETY in good standing, residing in the general locality where the Section is to be formed, of whom one at least shall be an Active Member. To be considered at any given meeting an application must be filed with the Secretary at least thirty days prior to the date of the Meeting and notice that the application is pending must appear in the program of the Meeting. To be granted, the application must receive the affirmative vote of two-thirds of those present. In event of affirmative

action the SOCIETY will issue a charter to the applicants, authorizing them to form a Section under the name proposed. Charters for Local Sections may be temporarily suspended by the Board of Trustees for cause, but no charter can be permanently rescinded except by vote of two-thirds of those present at a regular Meeting of the SOCIETY, after due publication in the program of the Meeting that the matter is pending.

(4) Local Sections shall have power to make their own rules and by-laws except that they shall not pass any rule or by-law which is in conflict with the rules of the SOCIETY.

(5) The officers of Local Sections shall be a Chairman, a Secretary, a Councillor, and such others as the Sections may prescribe. The duties of the Chairman and Secretary shall be such as usually pertain to those offices. The Councillor shall be an Active Member of the SOCIETY. He shall be elected by the Local Section and it shall be his duty to advise the Section in all matters pertaining to its relations with the SOCIETY and to make an annual report to the SOCIETY regarding the work and status of the Section. The names of the Chairman, Secretary, and Councillor of each Section shall appear in the roster of the SOCIETY.

Article X

Student Branches

(1) Student Branches, each carrying some distinguishing title prefixed to the words "Student Branch of the AMERICAN CERAMIC SOCIETY," may be established in institutions in which regular courses of instruction in ceramics are maintained.

(2) The purpose of such Student Branches shall be to strengthen and extend the work of the SOCIETY, as defined in Section I of the Rules, by enlisting the interest and support of students in ceramics while still in school and by stimulating the spirit of ceramic research among them.

(3) Application to form a Student Branch in any institution must be in writing, signed by not less than five regularly enrolled students in good standing, and endorsed by two or more members of the SOCIETY. The application must be filed and acted upon as provided for Local Sections in Section IX, and may be suspended or revoked for cause in the same manner.

(4) Student Branches shall have power to make their own rules and by-laws, except that they shall not pass any rule or by-law in conflict with the rules of the SOCIETY.

(5) The officers of Student Branches shall be a Chairman, a Secretary, a Councillor, and such others as the Student Branch may prescribe. The Chairman and Secretary shall be elected by the Student Branch and their duties shall be such as usually pertain to those offices. The Councillor shall be an Active Member of the SOCIETY, appointed by the Board of Trustees to act in this capacity to the Student Branch. The duties of the Councillor shall be to advise the Student Branch in all matters pertaining to its relations to the SOCIETY and to make an annual report to the SOCIETY regarding the work and status of the Student Branch. The names of the Chairman, Secretary, and Councillor of each Student Branch shall appear in the roster of the SOCIETY.

Article XI

Publications

(1) The Board of Trustees shall employ at suitable compensation an Editor of the *Journal of the American Ceramic Society* and an Advertising Manager, both of whom shall be nominated by the Committee on Publications to the Board of Trustees.

(2) The Committee on Publications shall have general supervision of the publications of the SOCIETY and of contracts and expenditures connected therewith, subject to the approval of the Board of Trustees.

(3) In the consideration of papers offered for presentation or publication those

papers containing matter readily found elsewhere, those specially advocating personal interests, those carelessly prepared or controverting established facts, and those purely speculative or foreign to the purpose of the SOCIETY shall be rejected. The Committee on Publications shall determine which papers shall be printed. The Committee may return a paper to the writer for change or correction and may call to its aid one or more members of special experience relating to the subject treated, either to advise on the paper or to discuss it.

(4) All papers, discussions, and other writings which have been presented before the SOCIETY, its Divisions, or Sections, and all committee reports shall become the property of the SOCIETY. Their publication or other disposition shall be in the hands of the Committee on Publications.

Any papers, discussions, or writings not considered suitable for use in the publications of the SOCIETY by the Committee on Publications must be released or returned to the authors for free use elsewhere and, upon request of authors, decision in this matter must be rendered within sixty days.

No reports prepared by a regularly appointed committee of the SOCIETY or of its Divisions or Sections shall be offered for publication elsewhere until the Committee on Publications shall have been given an opportunity of accepting such reports for publication by the SOCIETY.

(5) The Committee on Publications shall provide for the publication of a monthly periodical entitled the *Journal of the American Ceramic Society*, the subscription price of which shall be twelve and one-half dollars to members and fifteen dollars plus foreign postage to non-members.

(6) One copy of each issue of the paper bound edition of the *Journal* shall be sent prepaid to each member of the SOCIETY not in arrears. No member shall be furnished with more than one copy of each issue free for any single year. A member may be permitted to complete by purchase one file of the publications of the SOCIETY at less than the current commercial rate, the amount to be fixed by the Board of Trustees and to be called the member's rate.

(7) The Secretary shall have the custody of all publications of the SOCIETY, shall keep them safely stored and insured, and shall sell them to the public at prices which shall be fixed by the Board of Trustees. The Board of Trustees shall also, from time to time, fix the price of the volumes remaining unsold and shall have authority to refuse to sell the back volumes of the *Transactions* and *Journals* except in complete sets, at such time as the quantity remaining of any number becomes so small as in its judgment to warrant such action.

(8) The Editor shall request the author of each article appearing in the *Journal of the American Ceramic Society* to fill out and sign, within a definite time limit, a form, specifying the number of reprints of said article, if any, which he desires. This form shall contain a table from which can be computed the approximate cost at which any reprints will be furnished. In event that the expense of furnishing the desired number of reprints is large, the Board of Trustees may require the author to pay part or all of the cost involved before the publication of the reprints is begun. On receipt of such signed order within the time limit set the Editor shall cause to have printed the desired number of copies. If the author makes no reply or replies after the time limit has expired then the SOCIETY will not be responsible for the publication of any reprints of the article in question except at the usual market price for the printing of new matter.

(9) No one shall have the right to demand the publication of an article independently of the discussion which accompanied it and no one having taken part in a discussion upon an article shall be entitled to order reprints of the discussion separately and apart from the article itself.

(10) The SOCIETY is not, as a body, responsible for the statement of facts or opinions expressed by individuals in its publications.

Article XII

Parliamentary Standard

Roberts' "Rules of Order" shall be the parliamentary standard on all points not covered by these rules.

Article XIII

Amendments and Changes

Any proposed amendment to or change in this Constitution must be presented in writing at the Annual Meeting of the SOCIETY and, if approved by the Committee on Rules, must be printed on a ballot and sent out not earlier than thirty nor later than sixty days after the adjournment of the Meeting at which the amendment or change was presented. If the said letter ballot shows an affirmative vote of not less than two-thirds of the total vote cast within thirty (30) days after the date of mailing, then the same shall be declared carried and shall at once become effective.

Article XIV

By-Laws

The SOCIETY shall make such By-Laws not in conflict with this Constitution as may be necessary for the proper government of the SOCIETY. Such By-Laws shall become operative when approved by the Board of Trustees and confirmed by a two-thirds affirmative vote of the members voting at any Annual Meeting.

Section I

Meetings

(1) The Annual Meeting shall take place on the first Monday in February, or as soon thereafter as can be arranged, at such place as the Board of Trustees may decide, at which time reports shall be made by the Board of Trustees, Treasurer, and scrutineers of election, and the accounts of the Treasurer shall be audited by a committee of three appointed by the President. Fifty Active Members shall constitute a quorum at the Annual Meeting and a majority shall rule unless otherwise specified.

(2) Other meetings may be held at such times and places during the year as the Board of Trustees may decide, but at least twenty days' notice shall be given of any meeting.

(3) The President shall appoint at the Annual Meeting a committee of five, to be known as the Summer Meeting Committee, whose duty it shall be to arrange for a summer excursion meeting at some suitable point. They shall then select a local committee which shall have charge of the details of the meeting. The expenses of the Summer Meeting Committee in arranging the program of visits and for printing, rooms, and facilities for meetings shall be borne by the SOCIETY.

Section II

(1) At the Annual Meeting of the SOCIETY, the order of business shall be as follows:

1. President's Address
2. Reading of Minutes of Last Meeting
3. Committee Reports

4. Reports of the Board of Trustees and Treasurer
5. Old Business
6. New Business
7. Reading of Papers
8. Announcement of Election of Officers, Honorary Members, Fellows, and Active Members
9. Installation of Officers
10. Appointment of Committees
11. Adjournment

Section III

Only Fellows and Active Members shall be eligible to election as officers.

Section IV

Any members in arrears for over one year may be suspended from membership by the Board of Trustees until such arrears are paid. Fellows and Active Members in arrears are not eligible to vote. The Annual Dues are payable on January 1.

Section V

The Secretary of the Fellows, and of each Division, Local Section, and Student Branch shall report to the Secretary of the SOCIETY the names of its officers, and Chairmen of its Committees, within three weeks of their election or appointment, and shall also furnish the Secretary with a complete list of its membership on April 1 of each year.

Section VI

(1) Any person interested in the ceramic and allied industries is eligible to membership in a Local Section.

(2) Local Sections shall have power to fix their own dues or assessments, such dues or assessments being in addition to and independent of the regular dues and assessments of the SOCIETY upon its members. No Section shall have authority to incur debt in the name of the SOCIETY or for which the SOCIETY may become liable.

Section VII

(1) Membership in a Student Branch shall be limited to the instructional force and regularly enrolled students of schools in which branches are located, subject to the rules of the school concerned governing outside activities of students.

(2) Student Branches shall have power to fix their own dues and assessments and as such shall pay no dues to the SOCIETY. No Student Branch shall have authority to incur debt in the name of the SOCIETY or for which the SOCIETY may become liable.

(3) Members of a Student Branch shall pay no dues to the SOCIETY but, upon depositing a certificate of good standing from their Secretary, may purchase from the SOCIETY its publications at the same rate as Associate Members of the SOCIETY. This privilege shall cease when the student's connection with the school ceases, but members of a Student Branch, upon leaving school, may at once become Associate Members of the SOCIETY by depositing their certificates, making proper application, and paying the regular dues.

Section VIII

(1) The Board of Trustees shall appoint such special committees as may seem necessary for the proper conduct of the affairs of this SOCIETY.

(2) All special coöperative committees shall be appointed only on nomination of the Coördinating Service Council.

Section IX

To provide for rotation of the nominations of Trustees as representatives of the Divisions, as provided in Articles IV and V of the Constitution, some shall be nominated in 1923 to serve portions of the three-year terms as follows:

Terra Cotta to serve three years
Enamel to serve one year
Refractories to serve one year
White Wares to serve two years
Art to serve one year
Structural Clay Products to serve three years
Glass to serve two years

The Materials and Equipment Division, authorized by the Trustees in 1931, shall nominate a Trustee in that year to serve two years and thereafter shall nominate a Trustee for three-year terms in accordance with Article V, Paragraph (4).

Section X

The Board of Trustees shall have power to make any rules not inconsistent with the Constitution and By-Laws for the conduct of its business.

PRESIDENT ESKESEN ATTENDS MEETING OF FRENCH CERAMIC SOCIETY

The Syndicate des Fabricant de Produits Céramiques de France (French Ceramic Society) held its Annual Congress in Paris on May 31 and June 1. The meeting opened the International Colonial Exposition which is being held in Paris.

The AMERICAN CERAMIC SOCIETY was represented at this Meeting by its president, Eckardt V. Eskesen, who arrived in France on May 31. Cullen W. Parmelee, head of the Ceramic Engineering Department, University of Illinois, who with Mrs. Parmelee has been in Europe since last August, also represented the AMERICAN CERAMIC SOCIETY at this Paris meeting.

MATERIALS AND EQUIPMENT DIVISION

This Division had a business meeting on June 11 at Asbury Park, N. J. By-Laws were approved, subject to acceptance by the Rules Committee of the SOCIETY. The program for the Annual Meeting the week of February 7, 1932, in the Willard Hotel, Washington, D. C., was discussed and committees were appointed to care for the several suggested activities.

This Materials and Equipment Division will meet a need which the SOCIETY has been experiencing for several years. The members' need is the SOCIETY'S need. This SOCIETY is nothing else but "members," as are all organizations having voluntary memberships.

"Peddlers," some style themselves. "Opportunists" would be more fitting. The Materials and Equipment Division members translate ceramic requirements into terms of standardized material and adapted equipment, thus providing the opportunities for improved ware at lower costs. They travel about offering these opportunities. They peddle opportunities.

The Division will contribute in a large way to progress in ceramics.

LOCAL SECTION NEWS

Baltimore-Washington Section[1]

The Baltimore-Washington Section held a monthly meeting on Friday, May 8, 1931, at 6:30 P.M. at the Tilden Gardens Club Building, Washington, D. C.

The speakers and their subjects were:

(1) "Liquid Immiscibility as Exemplified by Borate and Silicate Melts," by Louis Navias, General Electric Co., Schenectady, N. Y.
(2) "Use of X-Ray in Studying Ceramic Materials," by Herbert Insley, Bureau of Standards, Washington, D. C.

These subjects were of interest to the members, as they dealt with rather recent developments in the ceramic field and will be used more extensively in the future.

The effects of immiscibility are more extensive than is ordinarily realized and Dr. Navias has spent much time in the study of this phase of ceramics.

We have all heard of the many fields in which the X-ray has been used and what it has helped to accomplish, but very little use has been made of it in the ceramic field. Dr. Insley has been doing work along this line.

These subjects are not merely dry abstracts, but are interesting and have a direct bearing on the study and proper understanding of ceramic materials. Those who have heard them discussed recommend them very highly.

Pittsburgh Section[2]

About sixty members of the Pittsburgh Section of the AMERICAN CERAMIC SOCIETY were guests on May 7 of the East Liverpool Ceramic Engineer's club. The guests were taken on a tour of inspection of the Hall China and the Patterson Foundry & Machine Companies' plants.

Following the tour of the plants, the guests were entertained at dinner at the Travelers' hotel, where addresses were made by Attorney Walter B. Hill, Ross C. Purdy, general secretary of the AMERICAN CERAMIC SOCIETY, and A. V. Bleininger, research engineer of the Homer Laughlin China Co. L. G. Tait, instructor of the local ceramic school, was toastmaster and H. B. DuBois was chairman of the committee.

Early History of Pottery in East Liverpool

Walter B. Hill, dealing with the subject "Why Pottery in East Liverpool?" traced briefly the early history of the ceramic city, recalling the familiar names of Kuntz, Baggott, Bloor, Brunt, Smith, and Bennett, pioneer families in the development of the pottery industry. He related many amusing incidents particularly in the life of James Bennett and his associates.

Business Outlook for 1933

Ross C. Purdy, the second speaker, referred in humorous and serious vein to the early history of East Liverpool and its pottery development with which he is quite familiar.

Covering his subject "Chicago in 1933," Mr. Purdy said that the condition of the ceramic industry in this country is such that it is difficult to secure the needed capital to depict properly the progress of the industry during the last century, and it is of prime importance that this be done as other countries of the world will carry out such a program, and, if America is to advance in this important work, as it no doubt will, this is a necessary step in its progress. He expressed faith in the return to normal business con-

---

[1] Edwin B. Filbert, *Secretary-Treasurer*.

[2] *Potters' Herald*, May 14, 1931.

ditions in 1933, the year of the World's Fair in Chicago, and emphasized among other things the importance of bringing to the attention of the American people the fact that ceramic products made in this country are as good and in many instances better than the foreign products. He also urged better marketing of American ware.

Importance of Vision in Industry

Dr. A. V. Bleininger, citing the necessity of vision in industry, said that change is ever present. We cannot remain stationary, either we advance or recede. Civilization is constantly changing and it is the business of industry to see in which direction we are headed. He pointed out that changes are coming at an alarming rate through the introduction of new methods and they are presenting a complicated mathematical equation which we must solve. "The thinking," said the speaker, "is being done by a comparatively small group."

He also stated that industry is engaged in a great conflict in which there is corporation against corporation and county against county in an effort to reduce cost and secure the markets.

Dr. Bleininger traced briefly the evolution of the glass, enamel, and pottery industries showing how competition in each is calling for their best effort in order to survive in this conflict and to meet the arch enemy, foreign competition. He also touched upon the brick, terra cotta, and various other competing industries.

He closed with a personal talk to the technical group emphasizing very strongly the importance of each of the following topics: Study of Raw Materials, Fuel Economy, Control of Heat, Close Coöperation with Plant Executives, Application of Applied Art, Hard and Constant Research, Control of Quality Products, Carrying on of Fundamental Research, Informal Information for Executives, and Development of all Possible Vision and a Spirit of Philosophy.

Each guest was presented with a souvenir ash tray made of native clay in various colored mat glazes by the students in the local ceramic school. Besides the club members and Pittsburgh visitors, there were present representatives of the National Brotherhood of Operative Potters and plant executives from East Liverpool and surrounding towns.

NEW MEMBERS RECEIVED IN MAY

CORPORATION

Amsler-Morton Co., Inc., P. L. Geer (voter), 720 Fulton Bldg., Pittsburgh, Pa.
Cambria Clay Products Co., S. P. Reitz (voter), Blackfork, Ohio.
North State Feldspar Corp., W. F. Deneen (voter), Micaville, N. C.

PERSONAL

Wilfrid George Ball, "Meadowcroft," Weston Coyney, Stoke-on-Trent, England; Research Chemist, Blythe Colour Works.
George Delangre, 48 Boulevard Froissart, Valenciennes, Nord, France.
Arthur E. Eaton, President, Mineral Wells Clay Products Co., Box 92, Mineral Wells, Texas.
N. J. Haley, Tata Iron & Steel Co., Ltd., Jamshedpur, India.
Sidney C. Horn, Sales Manager, Wilson-Maeulen Co., Inc., 383 Concord Ave., New York, N. Y.
J. A. Murray, Chief Chemist, Warner Company, 1616 Walnut St., Philadelphia, Pa.
J. M. Powell, President, Indiana Drain Tile Co., Brooklyn, Ind.

STUDENT

James H. Ammerman, Pennsylvania State College, State College, Pa.
Glenn G. Bernard, Ohio State Univ., Columbus, Ohio.
Stanley J. Tompach, Missouri School of Mines and Metallurgy, Rolla, Mo.

Membership Workers' Record

Corporation		Personal	
F. C. Flint	1	Louis Douin	1
Office	2	Office	6
Total	3	Total	7
		Grand Total	13

Student	
G. J. Bair	1
C. M. Dodd	1
Office	1
Total	3

ROSTER CHANGES IN MAY

Personal*

Burchfiel, B. M., Gladding, McBean & Co., Alberhill, Calif. (2901 Los Feliz Blvd., Los Angeles, Calif.)

Burr, Robert B., 15920 Clifton Blvd., Lakewood, Cleveland, Ohio. (Columbus National Bank, Columbus, Ga.)

Butler, Matthew W., 692 East 115th St., Cleveland, Ohio. (740 Oak St., Cincinnati, Ohio.)

Christensen, John B., Jr., 345 West 90th St., Los Angeles, Calif. (228 South J. St., Lompoc, Calif.)

Cohn, Willi M., The Ambassador, 1737 Cambridge St., Cambridge, Mass.; Arthur D. Little, Inc. (Berlin-Charlottenburg 2, Germany.)

De Solorzano, Tomas O., Calle de Alberto Bosch No. 9, Madrid, Spain. (Apartado de Correos No. 78, Gijon, Spain.)

Eddy, Allerton, 514 S. Main St., Middletown, Ohio. (33 W. Washington St., Newman, Ga.)

Ellis-Anwyl, Robert H., 22 W. Falls St., New Castle, Pa. (Box 67, East Canton, Ohio.)

Emley, William S., III, Farrell Arms Plaza, Washington, N. J. (103 S. Cornwall Ave., Ventnor City, N. J.)

Geller, R. F., 306 W. Thornapple, Chevy Chase, Md. (5425 Connecticut Ave., Washington, D. C.)

Greene, Charles F., 102 Wood St. West, Flint, Mich. (2006 Warlick Place N. E., Kirkwood, Atlanta, Ga.

Greene, Kenneth F., Gordon Art Tile Co., Bordentown, N. J. (Triteleon Lodge, 502 George St., New Brunswick, N. J.)

Hardy, R. G., 133 Maple Heights, New Lexington, Ohio. (204 Ceramics Bldg., Urbana, Ill.)

Helser, Perry D., General Ceramics Co., 71 West 35th St., New York, N. Y. (Eljer Co., Ford City, Pa.)

Herron, Henry R., Harbison-Walker Refractories Co., Vandalia, Mo. (K. A. Fraternity House, Rolla, Mo.)

Hofstetter, Gerald W., Seeger Refrigerator Co., St. Paul, Minn. (Westinghouse Electric & Mfg. Co., Mansfield, Ohio.)

Howell, Harriet, 2452 Charny Road, University Heights, South Euclid, Ohio. (3551 Winchell Rd., Shaker Heights, Cleveland, Ohio.)

Krieg, William H., 1219 W. Bancroft, Toledo, Ohio. (530 Riverside Drive, Kohler, Wis.)

Kuechler, A. H., Cloverport, Ky. (Wellsville, Mo.)

Long, R. N., 108 Moull St., Newark, Ohio. (Red Wing Union Stoneware Co., Red Wing, Minn.)

* Addresses within the parentheses ( ) represent the old address.

These roster changes which appear each month may be checked against the complete Membership Roster which was published in the July, 1929, issue of the *Bulletin*. Copies of this issue may be obtained from the Secretary's office, price $2.00.

Luks, Dan, 12 Carroll St., Trenton, N. J. (Membership transferred from Herbert Sinclair.)
Matthews, Samuel, Dominion Fire Brick and Clay Products, Ltd., Claybank, Saskatchewan, Canada. (Univ. of Saskatchewan, Saskatchewan, Canada.)
Moore, H. W., 326 Chestnut St., Moorestown, N. J. (4229 Decatur St., Holmesburg, Philadelphia, Pa.)
Nagle, J. A., 30 Acton Rd., Columbus, Ohio. (Carling Tile Co., Macon, Ga.)
Oesterle, Albert, 4635 E. 52nd Drive, Los Angeles, Calif. (Maywood, Calif.)
Ogden, Ellsworth P., Freyn Engineering Co., c/o Kuznetskstroy, Kuznetsk, Siberia, U.S.S.R. (1957 Chelsea Road, Columbus, Ohio.)
Peters, Bernard C., Danbury, Iowa. (157 Hyland Ave., Ames, Iowa.)
Richardson, Gordon B., Box 999, Livermore, Calif; W. S. Dickey Clay Mfg. Co. (Gladding, McBean & Co., Alberhill, Calif.)
Roth, H. A., 3305 W. Forest Home Ave., Milwaukee, Wis.; Rundle Mfg. Co. (38th and River Rd., Camden, N. J.)
Schaeffer, J. A., Eagle-Picher Lead Co., Jopkin, Mo. (305 St. Clair Ave., E. St. Louis, Ill.)
Tucker, Gus M., Indianapolis Terra Cotta Co., Olney and Roosevelt Sts., Indianapolis, Ind. (P. O. Box 155, Jackson Heights, N. Y.)
Watts, H. L., 27 Holton Ave., S., Hamilton, Canada. (111 Spadina Rd., Toronto 5, Canada.)
Williams, George A., 450 Westminster Ave., Elizabeth, N. J. (Piffard, N. Y.)
Wyer, Neal, 339 W. 9th Ave., Columbus, Ohio. (329 Edgewood St., North Canton, Ohio.)
Zoller, M. M., Eagle-Picher Lead Co., Temple Bar Bldg., Cincinnati, Ohio. (241 Church Road, Winnetka, Ill.)

NOTES AND NEWS

DR. CHARLES FERGUS BINNS

Dr. Binns has reached that age on the attainment of which the New York State laws require that teachers shall retire. Dr. Binns has earned his retirement on pension, and continuance in the academic life at Alfred University in an emeritus relation.

Dr. Binns is not aged; his mind is alert and his interests are broad. Through the many years of continuous teaching at Alfred and of co-laboring with his fellow ceramists nationally Dr. Binns has been increasing in productiveness. His leadership and helpful influence will continue.

It has been his good fortune to break ground for the three ceramic buildings on the Alfred University campus. He lifted the first spade of dirt this June for the foundation of a building larger and more suitable for Alfred's growing school of ceramics.

In honor of Dr. Binns, the AMERICAN CERAMIC SOCIETY delegated Edward Orton, B. E. Salisbury, Karl Langenbeck, Albert V. Bleininger, and William Cannon to attend the Alfred commencement convocation.

MORE HONORS TO EDWARD ORTON, JR.

Doctor of Laws, L.L.D., was conferred on General Orton by New York State College of Ceramics, Alfred University. This was in recognition of his accomplishments in metallurgy, in geology, in ceramics, in military, in civic government, in charities, and in literature. He received the honorary degree of Doctor of Science from Rutgers University a few years ago.

As founder of the world's first college of ceramic engineering; as the one delegated to organize the AMERICAN CERAMIC SOCIETY; as the secretary of this SOCIETY for the first twenty years; as an effective army officer (D.S.M.); as a practical geologist, our Edward Orton is the recipient of fellow memberships, honorary memberships, degrees, and

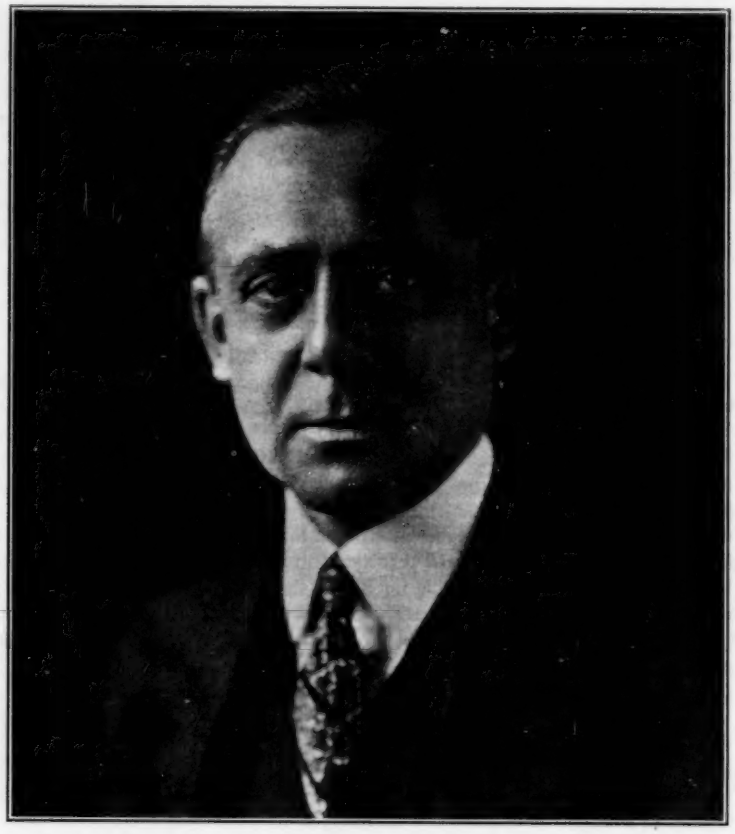
testimonials from various organizations and schools. A mountain is named for him. A recreation camp for unfortunate children bears his name. His fellow townsmen give him credit for successful leadership in many civic enterprises including the building of a fine arts museum and school.

And with it all he is simply our fellow ceramist and a good scout.

NECROLOGY

Porter S. Kier

Members of the AMERICAN CERAMIC SOCIETY will feel keenly the loss of Porter S. Kier, who died suddenly at his home on May 24 at the age of fifty-two years. Mr. Kier was vice-president and treasurer of the Kier Fire Brick Co., Pittsburgh, Pa. He



PORTER S. KIER

had been associated with the company for twenty-five years, a business which was founded in 1845 by Mr. Kier's grandfather, Samuel M. Kier.

Mr. Kier was also a director of the American Refractories Institute and president and director of the State Bank at Salina, Pa. He was particularly interested and active in

the Refractories Fellowship at Mellon Institute and Chairman of its Committee for many years.

Mr. Kier was a graduate of the Western University of Pennsylvania and the University of Pennsylvania.

Samuel M. Kier, brother of Porter S. Kier, was formerly president of the Kier Fire Brick Co., now vice-president of the General Refractories Co.

Dean Samuel Walker Beyer

Dean Samuel Walker Beyer of the Industrial Science Division, Iowa State College, died on June 2 at Iowa Falls, Iowa. Dean Beyer was geologist of the Iowa Geological Survey since 1892. With I. A. Williams he was co-author of the Annual Report, 1903, Iowa Geological Survey, Volume 14, devoted chiefly to the technology, chemistry, geology, and tests of clays and clay products in Iowa and he also wrote a number of other books on Iowa geological studies.

Dean Beyer was a member of the American Association for the Advancement of Science, the Iowa Academy of Science, the Geological Society of America, the Geological Society of Washington, and the American Institute of Mining Engineers. He was also for many years the faculty representative for Iowa State College in the Big Six Athletic Conference and chairman of several committees of the National Collegiate Athletic Association.

THE OHIO CERAMIC INDUSTRIES ASSOCIATION

Heavy Clay Products Division

The spring meeting of the Heavy Clay Products Division was held Wednesday, May 20, at the Shady Hollow Country Club, Massillon, Ohio.

The program was as follows:

(1) Short talk by the Secretary, H. E. Nold
(2) Report of Researches at Roseville by G. A. Bole
(3) New Developments in Dry Pressing by J. O. Everhart
(4) Discussion
(5) Ohio Shale Investigation by Chester Austin
(6) Roundtable discussion of future research program at Roseville

The meeting adjourned at 3 P.M.

White Ware Division

The White Ware Division held its spring meeting Thursday, May 28. (Golf at Sebring Country Club, trophy won by W. Keith McAfee.) Two plants at Sebring, Ohio, were visited in the afternoon and the technical session was held after dinner at the Alliance Country Club, Alliance, Ohio. The program was as follows:

(1) Present Economic Situation from Employment Curves by Dr. Spurgeon Bell
(2) Report of Ball Clay Investigation by G. A. Loomis
(3) Washed Fire Clay as a Constituent in Whiteware Bodies by M. C. Shaw
(4) The Elimination of Water Stains by G. A. Bole

NOTE: The ball clay study is an actual plant study of the American ball clays incorporated into bodies in different proportions and made up into ware fired and glazed. Color, shrinkage, strength, warpage, crazing, impact, and coefficient of expansion tests are being run on ware fired at six positions in a tunnel kiln.

NEW JERSEY CLAY WORKERS ASSOCIATION

The summer meeting of the New Jersey Clay Workers Association was held in the new Convention Hall, Asbury Park, N. J., on Friday, June 12. The headquarters were at the Berkeley-Carteret Hotel.

The program for the business session which was held in the morning was as follows:

(1) "This Business of Broadcasting," by Frank A. Arnold, Director of Development, National Broadcasting Co., New York, N. Y.
(2) Symposium: Advertising and Marketing Ceramic Products to Better Advantage.

In the afternoon a card party and a golf tournament were held.

CHICAGO DISTRICT ENAMELERS CLUB

The fourth annual banquet of the Chicago District Enamelers Club was held Tuesday, May 26, at Stickney, Ill. M. E. Manson is president, E. R. Brauner, vice-president, and F. E. Hodek, secretary of this club.

CALENDAR OF MEETINGS

Organization	Date	Place
American Assn. for the Advancement of Science	December 28, 1931 to January 2, 1932	New Orleans, La.
AMERICAN CERAMIC SOCIETY	February 7–13, 1932	Washington, D. C.
American Chemical Society	August 31–Sept. 4	Buffalo, N. Y.
American Gas Assn.	October 12–18	Atlantic City, N. J.
American Glassware Mfrs., Inc.	July 13	Atlantic City, N. J.
American Society of Mechanical Engineers	September 7–9	Kansas City, Mo.
American Society for Steel Treating	September 21–25	Boston, Mass.
Electrochemical Society	September 2–5	Salt Lake City, Utah
National Assn. of Manufacturers	October 5–9	New York, N. Y.
National Exposition of Power and Mechanical Engineering	December 5–10	New York, N. Y.
National Glass Distributors Assn.	December 1–3	Pittsburgh, Pa.
National Safety Council	October 12–16	Chicago, Ill.
New Jersey Clay Workers Assn.	October	Trenton, N. J.
Sand-Lime Brick Assn.	February 3–4, 1932	Washington, D. C.
Taylor Society, Inc.	December 2–4	New York, N. Y.
Tile & Mantel Contractors' Assn. of America, Inc.	February 9–12, 1932	Rochester, N. Y.

» » » » » » MADE BY CONTINUOUS PROCESS

"Pioneers in Continuous Sheet Rolling"

"Let's get back to fundamentals, Bill"

"REMEMBER YESTERDAY, BILL, when the Armco Consultant was here . . . Well, he told us some things we didn't know as well as some we needed reminding about."

"You're right, Art. He reminded me that all enameling troubles can be traced to one of three things: 'faulty plant practice, poor enamel, or inferior base metal.' Whether its chipping, blistering, warping, buckling, pin heads, crazing, or what not, it can be pinned to one or more of these three fundamentals."

"I was surprised, though, when he came back with his little black notebook and explained our troubles so clearly. Didn't expect it . . . thought he was going to turn out like so many of these trouble-hunters who come in and try to tell us what it's all about. But this chap knew his business . . . told me frankly what was the cause of our difficulty . . . pointed out, too, how more uniform refined iron would give us better and more consistent results."

"Pays to get back to fundamentals now and then, doesn't it, Bill?"

PERHAPS INCIDENTS like this suggest to you how an experienced Armco Consultant can help you achieve more efficient and profitable enameling practice. His services are free. Call him in, from the nearest office.

THE AMERICAN ROLLING MILL COMPANY
Executive Offices: MIDDLETOWN, OHIO
Export: The Armco International Corporation
DISTRICT OFFICES: *Chicago · Cincinnati · Cleveland · Detroit New York · Philadelphia · Pittsburgh · St. Louis · San Francisco*

ARMCO

INGOT IRON
the world's STANDARD
· ENAMELING IRON ·

BUYERS' GUIDE

A

Aloxite (Refractory Products)
Carborundum Co.

Alumina (Hydrate and Calcined)
Harshaw Chemical Co.
Hommel, O., Co.
Pennsylvania Salt Mfg. Co.

Aluminum Oxide (Fused)
The Exolon Co.
Harshaw Chemical Co.

Alundum (Refractory Products)
Norton Co.

Ammonium Bifluoride
Harshaw Chemical Co.
Hommel, O., Co.

Ammonium Carbonate
Harshaw Chemical Co.
Hommel, O., Co.

Antimony Oxide
Harshaw Chemical Co.
Hommel, O., Co.

Auger Machines
Chambers Brothers Co.

Automatic Cutters
Chambers Brothers Co.

Automatic Stove Rooms
Philadelphia Drying Machinery Co.

Automatic Temperature Control
Brown Instrument Co.
Leeds & Northrup Co.

B

Ball Mills
Hommel, O., Co.
McDanel Refractory Porcelain Co.

Ball Mills (Laboratory Type)
Hommel, O., Co.

Barium Carbonate
Harshaw Chemical Co.
Hommel, O., Co

Barytes
Harshaw Chemical Co.
Hommel, O., Co.

Batts
Carborundum Co. (*"Carbofrax Aloxite"*)
Norton Co. ("Alundum-Crystolon")

Bentonite
American Colloid Co.

Bitstone
Harshaw Chemical Co.
Potters Supply Co.

Blocks (Refractory)
Carborundum Co.
Norton Co.

Boats, Combustion
Norton Co.

Borax
American Potash & Chemical Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
Harshaw Chemical Co.
Pacific Coast Borax Co.

Borax Glass
Harshaw Chemical Co.
Pacific Coast Borax Co.

Boric Acid (Anhydrous)
Hommel, O., Co.
Pacific Coast Borax Co.

Boric Acid (Crystal, Granular or Powder)
American Potash & Chemical Co.
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.
Pacific Coast Borax Co.

Brickmaking Machinery
Chambers Brothers Co.

Bricks (Refractory)
Carborundum Co. (*"Carbofrax Aloxite"*)
Norton Co. (*"Alundum-Crystolon"*)

Burners (Nat. Gas)
Swindell-Dressler Corp.

C

Carbofrax (Refractory Products)
Carborundum Co.

Carbolon (Refractory Products)
The Exolon Co.

Carbon Dioxide Meters
Brown Instrument Co.

Carbonates (Barium, Lead)
Harshaw Chemical Co.
Hommel, O., Co.

The National Silica Co.

OREGON, ILL.

Producers and Pulverizers of

FLINT

exclusively for

Pottery Purposes

99.97% Pure Silica **140 Silk Lawn Test**

Ceramic Service? We Give It

We Manufacture—

- Pins
- Stilts
- Thimbles
- Spurs
- Saggers
- Crucibles
- Tile for Decorating Kilns

We Sell—

- Ball Clay
- Sagger Clay
- Wad Clay
- Ground Fire Clay
- Bitstone
- Fire Brick
- Imported Paris White
- Domestic Whiting

THE POTTERS SUPPLY COMPANY

EAST LIVERPOOL, OHIO

(When writing to advertisers, please mention the JOURNAL)

BUYERS' GUIDE (continued)

Caustic Soda
Harshaw Chemical Co.
Pennsylvania Salt Mfg. Co.

Cements
Carborundum Co.
Norton Co.

Ceramic Chemicals
Drakenfeld and Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.
Metal & Thermit Corp.
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

Ceramic Plant Equipment
Chambers Brothers Co.
Harrop Ceramic Service Co.
Philadelphia Drying Machinery Co.
Swindell-Dressler Corp.

Chromium Oxide
Harshaw Chemical Co.
Hommel, O., Co.

Clay (Ball)
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
Hommel, O., Co.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Potters Supply Co.
Spinks Clay Co., H. C.

Clay (China)
Drakenfeld and Co., B. F.
Edgar Brothers Co.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
Hommel, O., Co.
Paper Makers Importing Co.

Clay (Electrical, Porcelain)
Edgar Brothers Co.
Harshaw Chemical Co.
Kentucky-Tennessee Clay Co.
Spinks Clay Co., H. C.

Clay (Enamel)
American Colloid Co.
Edgar Brothers Co.
Harshaw Chemical Co.
Hommel, O., Co.
Kentucky-Tennessee Clay Co.
Metal & Thermit Corp.
Paper Makers Importing Co.
Vitro Mfg. Co.

Clay (Fire)
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Potters Supply Co.

Clay (German Vallendar)
Harshaw Chemical Co.

Clay Miners
American Colloid Co.
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Spinks Clay Co., H. C.

Clay (Potters)
Harshaw Chemical Co.
Spinks Clay Co., H. C.

Clay (Sagger)
Edgar Brothers Co.
Harshaw Chemical Co.
Kentucky-Tennessee Clay Co.
Potters Supply Co.
Paper Makers Importing Co.
Spinks Clay Co., H. C.

Clay Tests
Harrop Ceramic Service Co.
Swindell-Dressler Corp.

Clay (Wad)
Harshaw Chemical Co.
Kentucky-Tennessee Clay Co.
Potters Supply Co.
Spinks Clay Co., H. C.

Clay (Wall Tile)
Harshaw Chemical Co.
Kentucky-Tennessee Clay Co.
Spinks Clay Co., H. C.

Clocks, Gauge Board
Brown Instrument Co.

CO_2 Meters
Brown Instrument Co.

Cobalt Oxide
Drakenfeld and Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.

Colors
Drakenfeld and Co., B. F.
Harshaw Chemical Co.
Hommel Co., O.
Vitro Mfg. Co.

Combustion Apparatus
Leeds & Northrup Co.

Numerical Documentation

THE ANNUAL TABLES OF CONSTANTS (A.T.C.)

AND NUMERICAL DATA

Chemical, Physical, Biological and Technological

collect, classify and publish since 1910 everything in Pure and Applied Natural Sciences liable of being expressed by a number.

(For the period 1910–1928) the **A.T.C.** *completes* and

(since 1928) *continues* the International Critical Tables (I. C. T.)

The **A.T.C.** are absolutely necessary to all scientists.

They represent

the only one complete documentation—the most inexpensive—the easiest to consult owing to an *Index* systematically arranged which enables one to locate *at once* the data required.

For any information—any specimen—any volume on free examination

Apply immediately to

Canada and U. S. A.

The McGraw-Hill Book Company, Inc.
370 Seventh Avenue
New York, U. S. A.

Other countries

M. C. MARIE
9, rue de Bagneux
Paris VI° France

Volumes published: 1st Series—I to V—1910–1922 (5382 pages) and Index
2nd " VI & VII—1923–1926 (3571 pages)

Specimens: Reprints of the following sections are sent free of charge: Spectroscopy—Electricity, Magnetism, Electrochemistry—Radioactivity—Crystallography, Mineralogy—Biology—Engineering and Metallurgy—Colloids—Wireless—Photography—Geophysics—Combustible gaseous mixtures, Powders and Explosives.

English versions: Beginning with Volume VII, all explanations to the tables are given in both English and French.

THE DAY WILL COME

when you will want a certain article in a three-year-old issue of some technical journal—and want it quick.

THAT IS THE DAY

to remember that more than one million back numbers of important magazines are waiting for your call on the shelves of the

Periodicals Department

THE H. W. WILSON COMPANY

964 University Avenue **New York City**

No trouble to quote prices

Periodicals bought and sold. Photostat service.

The Journal of the Society of Glass Technology

A quarterly Journal containing original papers and abstracts of papers covering the whole field of Glass Technology.

ANNUAL SUBSCRIPTIONS TO SOCIETY (Including Journal)

Ordinary Members	$ 7.50
Collective Members	15.00
Price per Number to non-Members	2.50
Price per Volume (unbound) to non-Members	9.00

Forms of application for membership may be obtained from the American Treasurer of the Society, Francis C. Flint, Washington, Pa.

Address orders and inquiries to: The Secretary, Society of Glass Technology, The University, Sheffield, England

BUYERS' GUIDE (continued)

Conditioning Machinery
Philadelphia Drying Machinery Co.

Cones (Filter)
Norton Co.

Controllers
Brown Instrument Co.
Leeds & Northrup Co.

Conveyers (Clay, Sand, Brick, etc.)
Philadelphia Drying Machinery Co.

Cores (Alundum Furnace
Norton Co.

Cornwall Stone
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
Hommel, O., Co.
Pennsylvania Pulverizing Co.

Cornwall Stone (Imported)
Harshaw Chemical Co.

Crucibles (Filter, Melting, Ignition)
Norton Co.
Potters Supply Co.

Crushers
Chambers Brothers Co.

Cryolite
Harshaw Chemical Co.
Hommel, O., Co.

D

Decorating Supplies
Drakenfeld and Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.
Vitro Mfg. Co.

Dishes (Alundum, Filtering, Ignition)
Norton Co.

Disintegrators
Chambers Brothers Co.

Disks (Alundum, Porous, Filter)
Norton Co.

Dolomite
Harshaw Chemical Co.

Driers
Harrop Ceramic Service Co.

Driers (China Ware, Porcelain)
Philadelphia Drying Machinery Co.

Drying Machinery
Philadelphia Drying Machinery Co.

E

Electrical Porcelain
Paper Makers Importing Co.

Electrical Instruments
Brown Instrument Co.
Leeds & Northrup Co.

Enameling Equipment, Complete
Chicago Vitreous Enamel Products Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.

Enameling Furnaces
Carborundum Co. (*Carboradiant*)
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Norton Co.
Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Enameling Muffles
Carborundum Co. (*Carbofrax*)
Norton Co.

Enameling, Practical Service
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp,
Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Enamels
Harshaw Chemical Co.
Hommel, O., Co.
Metal & Thermit Corp.

Enamels, Porcelain
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Metal & Thermit Corp.
Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Engineering Service
Chambers Brothers Co.
Harrop Ceramic Service Co.
Swindell-Dressler Corp.

ALPHABETICAL LIST OF ADVERTISERS

	Page
American Colloid Co.	26
American Potash & Chemical Corp.	25
American Rolling Mill Co.	7
American Telephone & Telegraph Co.	4
Brown Instrument Co.	2
Carborundum Co.	Inside Back Cover
Chambers Bros. Co.	19
Chicago Vitreous Enamel Product Co.	25
Classified Advertising	14
Drakenfeld & Co., B. F., Inc.	Inside Front Cover
Edgar Bros. Co.	21
Edgar Plastic Kaolin Co.	21
Exolon Co.	15
Ferro Enamel Corp.	27
Goebel, J. & Co.	19
Golding-Keene Co.	28
Hammill & Gillespie, Inc.	17
Hommel, O., Co.	5
Journal of the Society of Glass Technology	11
Kentucky-Tennessee Clay Co.	26
Leeds & Northrup Co.	1
McDanel Refractory Porcelain Co.	19
Metal & Thermit Corp.	Outside Back Cover
Miller Machine & Mold Works	25
National Silica Co.	9
Pacific Coast Borax Co.	15
Paper Makers Importing Co.	19
Pennsylvania Pulverizing Co.	21
Pennsylvania Salt Mfg. Co.	17
Philadelphia Drying Machinery Co.	28
Philadelphia Quartz Co.	23
Porcelain Enamel & Mfg. Co.	17
Potters Supply Co.	9
Professional Directory	14
Simplex Engineering Co.	27
Southern Feldspar, Inc.	28
Spinks, H. C., Clay Co.	24
Standard Flint & Spar Corp.	28
Swindell-Dressler Corp.	17
Tables Annuells de Constantes & Donnees Numeriques	11
Titanium Alloy Mfg. Co.	Center of Book
Vitro Mfg. Co.	23
Willson Products, Inc.	26
Wilson, H. W., Co.	11

(When writing to advertisers, please mention the JOURNAL)

PROFESSIONAL DIRECTORY

THE SHARP-SCHURTZ CO.
Chemists for the Ceramic Industry
We have fully equipped laboratories at
Lancaster, Ohio, U. S. A.

Petrographic Laboratory
W. Harold Tomlinson
Microscopic examinations.
All petrographic work.
114 Yale Ave.
Swarthmore, Pennsylvania

Established 1836
BOOTH, GARRETT & BLAIR
Analytical & Consulting
CHEMISTS
Accurate analyses of all types
of Ceramic Materials
Feldspar, Clay, Sand, Colors
Glass, Enamels, etc.
404-406 LOCUST STREET
PHILADELPHIA, PA.
The oldest commercial laboratory in America

DOWNS SCHAAF
Chemical & Metallurgical Engineer
Special Analyses
Research Projects
1433 Studer Ave. Columbus, Ohio

CLASSIFIED ADVERTISING

POSITION WANTED by Ceramic Engineer and Chemist. Plant, Laboratory, and Office experience. Age 27, single, location immaterial. Available immediately. Address Box 123-E, American Ceramic Society, 2525 N. High St., Columbus, Ohio.

CERAMIC ENGINEER, age thirty, married, experienced in refractories in research, plant construction and operation, desires permanent connection with reliable firm manufacturing any line of ceramic products. Best references. Address Box 124-E, American Ceramic Society, 2525 N. High St., Columbus, Ohio.

The Cost of Classified Advertising Is 35 Words for $1.00 and 5c for Each Word Additional

Emerson P. Poste
Consulting Chemical Engineer
Analyses: Ceramic Raw Materials and Products, Fuels, Iron and Steel, etc.
Special Investigations: Physical and Chemical Tests on Enamel, etc.
Box 51, North Chattanooga, Tenn.

Each Advertiser is entitled
to as many listings
in the BUYERS' GUIDE
as desired

BORAX *Guaranteed 99½%–100% Pure* BORIC ACID

Select the Brand which has back of it years of *successful use* by experienced Ceramists

Pacific Coast Borax Co., New York

Chicago Los Angeles

Refractory Materials

Products of the Electric Furnace

SILICON CARBIDE
SILICON CARBIDE FIRESAND
ARTIFICIAL MULLITE
FUSED ALUMINUM OXIDE
FUSED MAGNESITE

Furnished in raw material form, ground to meet specifications.

Our Research Department with fully equipped laboratories is always at your service.
WRITE US ABOUT YOUR PROBLEMS

THE EXOLON COMPANY

Established 1914

Electric Furnace Plant { THOROLD, ONTARIO
Finishing Plant, General Offices { BLASDELL, N. Y.

BUYERS' GUIDE (continued)

Equipment (Porcelain Enameling)
Chicago Vitreous Enamel Product Co.
Porcelain Enamel & Mfg. Co.
Ferro Enamel Corp.

Exolon (Refractory Products)
The Exolon Co.

Equipment (Safety)
Willson Products, Inc.

Extruding Machines (Lab. Use)
Chambers Brothers Co.

F

Fans
Philadelphia Drying Machinery Co.

Feldspar
Golding-Keene Co.
Harshaw Chemical Co.
Hommel, O., Co.
Pennsylvania Pulverizing Co.
Southern Feldspar, Inc.
Standard Flint & Spar Co.

Fire Brick
Carborundum Co.
Harbison-Walker Refractories Co.

Flint
Golding-Keene Co.
Harshaw Chemical Co.
National Silica Co.
Pennsylvania Pulverizing Co.
Southern Feldspar, Inc.
Standard Flint & Spar Co.

Flint Pebbles
Harshaw Chemical Co.
Hommel, O., Co.

Flow Meters
Brown Instrument Co.
Leeds & Northrup Co.

Frit
Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Furnace
Carborundum Co. (*Carboradiant*)
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Harrop Ceramic Service Co.
Porcelain Enamel & Mfg. Co.
Simplex Engineering Co.
Swindell-Dressler Corp.

G

Gas Analysis Meters
Brown Instrument Co.

Gauges (Indicating, Recording, Controlling; Draft; Depth; Liquid Level; Pressure; Remote; Temperature; Vacuum)
Brown Instrument Co.

Glass House Machinery
Miller Machine & Mold Works

Glass Tanks
Simplex Engineering Co.

Glass Plant
Simplex Engineering Co.

Glaze and Body Spar
Harshaw Chemical Co.
Hommel, O., Co.

Glazes and Enamels
Chicago Vitreous Enamel Product Co.
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.
Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Glaze Spar
Harshaw Chemical Co.
Hommel, O., Co.

Goggles
Willson Products, Inc.

Gold
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.
Vitro Mfg. Co.

H

Hearths
Carborundum Co.
(*Carbofrax* heat treating)
Norton Co.

Hearths (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
Carborundum Co.
Norton Co.

PEMCO
TRADE MARK REG. U.S. PAT. OFF.

For:
REFRIGERATORS
RADIO RESISTORS
BUTCHERS' FIXTURES
STOVES--Gas, Electric, Coal
WASHING MACHINE TUBS
WALL AND ROOFING TILE
AUTOMOBILE MANIFOLDS
BARBERS' SUPPLIES
SANITARY WARE
REFLECTORS
TABLE TOPS
NOVELTIES
SIGNS

PORCELAIN ENAMEL
ALWAYS CONSULT

PORCELAIN ENAMEL & MFG. CO.
Eastern and Pemco Aves.
BALTIMORE · MARYLAND
U·S·A.

Since 1848
Importers of

ENGLISH CHINA CLAYS
ENGLISH BALL CLAYS
CORNWALL STONE
TALC (STEATITE)

Dependable Qualities of Ceramic Materials for all Branches of the Industry

HAMMILL & GILLESPIE, INC.
225 Broadway
New York

There is a type of

DRESSLER TUNNEL KILN

for burning every kind of ware using the fuel that is economically most available, with capacity that meets your requirements.
Let our engineers advise you.

SWINDELL-DRESSLER CORPORATION

P. O. Box 1753 Pittsburgh, Pa.

PENNSYLVANIA SALT MANUFACTURING COMPANY

Executive Offices: Philadelphia, Pa.

Works: Philadelphia and Natrona, Pa., Wyandotte and Menominee, Mich.

Representatives:
New York Chicago
Pittsburgh St. Louis

PENNA. SALT MANUF'G. CO.
PURE
GREENLAND KRYOLITH
PHILADELPHIA, PA

BUYERS' GUIDE (continued)

Humidity Control
Leeds & Northrup Co.

Hydrogen Ion Equipment
Leeds & Northrup Co.

Hygrometers
Brown Instrument Co
Leeds & Northrup Co.

I

Indicators & Recorders (Steam, Air, Gas)
Brown Instrument Co.
Leeds & Northrup Co.

Indicators, Chemical
Leeds & Northrup Co.

Infusorial Earth
Harrop Ceramic Service Co.

Instruments (Temperature, Pressure)
Brown Instrument Co.
Leeds & Northrup Co.

Iron (Enameling)
American Rolling Mill Co.

K

Kaolin
Edgar Brothers Co.
Harshaw Chemical Co.
Hommel, O., Co.

Kilns
Harrop Ceramic Service Co.
Simplex Engineering Co.
Swindell-Dressler Corp.

Kilns (China, Decorating)
Drakenfeld & Co., B. F.
Hommel, O., Co.

Kilns (Electric)
Swindell-Dressler Corp.

Kryolith
Harshaw Chemical Co.
Hommel, O., Co.
Pennsylvania Salt Mfg. Co.

L

Leers (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
Carborundum Co.
Norton Co.

Leers (Low Heat, Muffle Type, Electric)
Simplex Engineering

Level Gauges (Indicating, Recording, Controlling; Boiler; Liquid; Water)
Brown Instrument Co.

Linings (Furnace Refractory, Block Refractory Plate, Brick and Tile)
Carborundum Co.
Norton Co.

Liquid Level Indicator and Recorder
Brown Instrument Co.
Leeds & Northrup Co.

M

Magnesia (Sintered, Calcined)
The Exolon Co.
Harshaw Chemical Co.
Norton Co.

Magnesite
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.

Manganese
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.

Manometers
Brown Instrument Co.

Masks (Breathing)
Willson Products, Inc.

Metals (Porcelain Enameling)
American Rolling Mill Co.

Meters (All Kinds)
Brown Instrument Co.

Millivoltmeters (Indicating, Recording, Controlling)
Brown Instrument Co.

Minerals
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.
Vitro Mfg. Co.

Mixing Machines
Chambers Brothers Co.

Motors
Harrop Ceramic Service Co.

Muffles (Furnace)
Carborundum Co. (*Carbofrax*)
Norton Co.

TRADE MARK

Pyrometer Tubes—Protection Tubes—Combustion Tubes
McDanel Refractory Porcelain Company
Beaver Falls, Pennsylvania

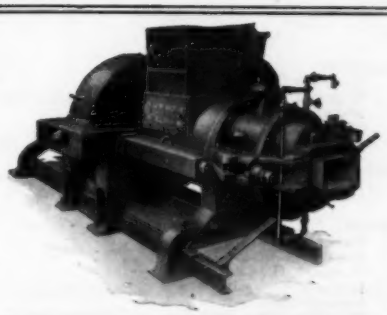
UNUSUAL · SHAPES · OUR · SPECIALTY

For BETTER
Glasshouse CLAY POTS and TANK BLOCKS
Insist on getting
GROSSALMERODE CLAY

Sold since 1865
by
J. GOEBEL & CO.
95 Bedford St.
NEW YORK

Brick Making Machines

Crushers Grinders Mixers
Automatic Cutters



Chambers Bros. Co.
Philadelphia Pennsylvania

PAPER MAKERS IMPORTING CO. INC. EASTON, PENNSYLVANIA U.S.A. PMI INC.

FINEST POTTERY CLAYS

BUYERS' GUIDE (continued)

Mullite (Artificial)
The Exolon Co.

Muriatic Acid
Harshaw Chemical Co.
Pennsylvania Salt Mfg. Co.

N

Nitrates (Cobalt, Sodium)
Harshaw Chemical Co.
Hommel, O., Co.

O

Opacifiers
Harshaw Chemical Co.
Hommel, O., Co.
Metal & Thermit Corp.
Titanium Alloy Mfg. Co.

Orifice Plates
Brown Instrument Co.

Oxides
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.
Metal & Thermit Corp.
Pennsylvania Salt Mfg. Co.
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

P

Pans (Wet and Dry)
Chambers Brothers Co.

Pebble Mills
Hommel, O., Co.

Pins
Potters Supply Co.

Placing Sand
National Silica Co.
Pennsylvania Pulverizing Co.

Plant Design
Harrop Ceramic Service Co.
Swindell-Dressler Corp.

Plate Feeders
Chambers Brothers Co.

Plate (Filter)
Norton Co.

Polariscope
Simplex Engineering Co.

Porcelain Enameling Service, Practical
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Porcelain Enamels
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Pot Furnaces
Simplex Engineering Co.
Swindell-Dressler Corp.

Potash (Carbonate)
Harshaw Chemical Co.
Hommel, O., Co.

Potassium Bifluoride
Harshaw Chemical Co.
Hommel, O., Co.

Potentiometers (Indicating, Recording, Controlling)
Brown Instrument Co.

Producer Plants
Simplex Engineering Co.

Protecting Tubes, Pyrometer
Leeds & Northrup Co.

Protecting Tubes, Thermocouple
Brown Instrument Co.

Protective Equipment
Willson Products, Inc.

Pug Mills
Chambers Brothers Co.

Pulverizing Mills
Hommel, O., Co.

Pyrometers (Indicating)
Brown Instrument Co.
Leeds & Northrup Co.

Pyrometers (Optical)
Leeds & Northrup Co.

Pyrometers (Recording)
Brown Instrument Co.
Leeds & Northrup Co.

Pyrometer (Switches)
Brown Instrument Co.
Leeds & Northrup Co.

Pyrometer Thermocouples
Brown Instrument Co.
Leeds & Northrup Co.

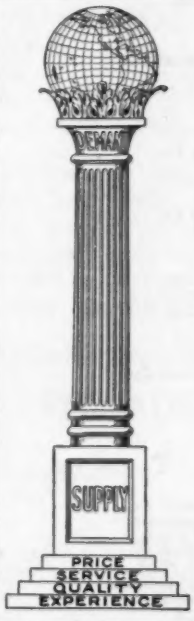
Pyrometer Tubes (Refractory and Hard Porcelain)
Brown Instrument Co.
Leeds & Northrup Co.
McDanel Refractory Porcelain Co.

PENNSYLVANIA PULVERIZING CO.
LEWISTOWN, PA.

Potters Flint **Placing Sand**

SALES OFFICE

323 Fourth Avenue
Pittsburgh, Pa.



EDGAR CLAYS

TRACE the history of American clay production and development—you will find EDGAR the outstanding name for high uniform quality. Year after year, time has proved the story for these famous clays that have pioneered the way for the manufacture of American wares from American clays.

There is an EDGAR CLAY for every use in unlimited quantity. A complete and reliable service, plus technical advice to customers and prospective customers without cost or obligation, have made EDGAR CLAYS the predominating name in the American clay industry.

When you think of clays, you think of EDGAR.

Department of Sales

EDGAR PLASTIC KAOLIN CO.
EDGAR BROTHERS CO.

Home Office
Metuchen, N. J.

New York Office
50 Church St.

Ceramic and Enameling Clays—Filler and Coating Clays for Paper, Rubber and Shade Cloth

BUYERS' GUIDE (continued)

R

Recorders (CO, CO_2, SO_2 and Draft)
Brown Instrument Co.
Leeds & Northrup Co.

Recording Instruments
Brown Instrument Co.
Leeds & Northrup Co.

Refractories
Carborundum Co.
The Exolon Co.
Norton Co.

Refractory Materials
The Exolon Co.
Norton Co.

Regulators (Automatic Temperature)
Brown Instrument Co.
Leeds & Northrup Co.

Remote Controllers, Indicators, Recorders
Brown Instrument Co.

Respirator
Willson Products, Inc.

Rutile
Harshaw Chemical Co.
Titanium Alloy Mfg. Co.

S

Safety Devices
Willson Products, Inc.

Sagger Presses
Chambers Brothers Co.

Saggers
Carborundum Co.
Norton Co.
Potters Supply Co.

Selenite of Sodium
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.
Vitro Mfg. Co.

Selenium
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.

Silica (Fused)
The Exolon Co.

Silicate of Soda
Harshaw Chemical Co.
Philadelphia Quartz Co.

Silicon Carbide
The Exolon Co.
Norton Co.

Silicon Carbide Firesand
The Exolon Co.

Sillimanite (Synthetic)
The Exolon Co.
Harshaw Chemical Co.

Slabs (Furnace)
Carborundum Co.
Norton Co.

Smelters
Chicago Vitreous Enamel Product Co.
Porcelain Enamel & Mfg. Co.

Soda Ash
Harshaw Chemical Co.
Hommel, O., Co.

Sodium Antimonate
Harshaw Chemical Co.
Hommel, O., Co.
Metal & Thermit Corp.
Vitro Mfg. Co.

Sodium Fluoride
Harshaw Chemical Co.
Hommel, O., Co.

Spar
Harshaw Chemical Co.
Hommel, O., Co.
Pennsylvania Pulverizing Co.

Spurs
Potters Supply Co.

Stilts
Potters Supply Co.

Sulphuric Acid
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Pennsylvania Salt Mfg. Co.

Switches
Brown Instrument Co.

T

Tachometers
Brown Instrument Co.
Leeds & Northrup Co.

Talc
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
Hommel, O., Co.

Beginning Another Century

PHILADELPHIA QUARTZ CO.

ONE HUNDRED YEARS furnish the background for experience and research to push on toward the next milestone, cognizant that the only thing constant is change.

Silicates of soda, our only products, have made chemical history and will yet find new applications in industry and afford refinements of known older uses in the next century of service.

General Offices and Laboratory

PHILADELPHIA

Branch Office: CHICAGO, ILL.

PQ

PROBLEM

VITRO

GLASS COLORS

ALL RAINBOW SHADES

OVERGLAZES
◆
UNDERGLAZES
◆
STAINS

POTTERY COLORS FOR EVERY NEED

LET VITRO HELP YOU SOLVE YOUR GLASS AND COLOR

VITRO MANUFACTURING CO.
PITTSBURGH - CORLISS STA.

BUYERS' GUIDE (continued)

Tanks
Simplex Engineering Co.

Temperature Controls
Brown Instrument Co.
Leeds & Northrup Co.

Temperature Instruments (Measuring)
Brown Instrument Co.
Leeds & Northrup Co.

Thermocouples
Brown Instrument Co.
Leeds & Northrup Co.

Thermometers (Electric Resistance, Indicating, etc.)
Brown Instrument Co.
Leeds & Northrup Co.

Thimbles (Filtering Extraction)
Norton Co.

Tile (Refractory)
Carborundum Co. (*Carbofrax*)
Norton Co.

Tile (Wall)
Paper Makers Importing Co.

Time Cycle Controller for Tunnel Kiln Pushers
Swindell-Dressler Corp.

Tin Oxide
Drakenfield & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.
Metal & Thermit Corp.

Titanium
Harshaw Chemical Co.
Hommel, O., Co.
Titanium Alloy Mfg. Co.

Tubes (Insulating)
McDanel Refractory Porcelain Co.
Norton Co.

Tubes (Pyrometer)
Brown Instrument Co.
Leeds & Northrup Co.
McDanel Refractory Porcelain Co.
Norton Co.

V

Valves (Automatic Control)
Brown Instrument Co.

Venturi Meters
Brown Instrument Co.

V-Notch Meters
Brown Instrument Co.

W

Wet Enamel
Chicago Vitreous Enamel Product Co.
Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Whiting
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.

Witherite
Harshaw Chemical Co.

Z

Zirconia
Harshaw Chemical Co.
Hommel, O., Co.
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

Mr. Ceramist—

We have { *The Clay*
The Facilities
The Experience

H. C. SPINKS CLAY CO.
Newport, Ky.

LUSTERLITE ENAMELS

THERE is satisfaction in knowing that the frit you purchase is of the finest quality and that the service is dependable.

There is greater satisfaction in knowing that the frit is *uniformly* fine and that the service is *consistently* dependable.

When you buy Lusterlite Frit you buy *product finish insurance.*

Chicago Vitreous Enamel Product Co.

CICERO ILLINOIS

BORAX

AND

BORIC ACID

* * *

GUARANTEED OVER 99½% PURE

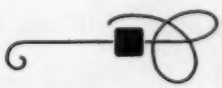
AMERICAN POTASH & CHEMICAL CORPORATION

Woolworth Bldg., New York City

MILLER MACHINE & MOLD WORKS

Manufacturers of

Machinery exclusively for the Glass Industry



705-719 Ann Street, Columbus, Ohio, U.S.A.

London Office—142 Audrey House, Ely Place, London, E.C. 1

Eight Years of Dependable Service

The popularity of the Willson LJ31½ all-purpose goggle has steadily increased in the eight years it has been in use. Every pair in use today was made from the original design. Except for the constant improvement of the quality of its parts, no change has been found possible which would increase its efficiency. Neither in that time has any change been necessary to assure constantly increasing popularity.

Like all other Willson Products, LJ31½ was thoroughly tested under actual working conditions before being offered to the trade. That it was of correct design was proved by its immediate acceptance and the constant growth of its army of users in many industries throughout the eight-year period.

LJ31½ incorporates such features as the Super-Tough lens which is optically perfect to a degree that reduces distortion and eye strain to a minimum, yet gives maximum protection against blows; the easy quick lens change; the shock absorbing eye cups and the comfortable sweat-proof non-inflammable padding.

The perfected design combined with Willson workmanship and a strict adherence to the practice of using only tested materials is assurance that LJ31½ will continue for a long time to enjoy its present popularity.

Price: $1.65, f. o. b., each in a metal case

WILLSON PRODUCTS, INC. READING, PENNSYLVANIA

Of Value to You
is our
Long Record
of
Plant Proven Dependability
for
Constancy in Quality
due to
Laboratory Controlled Inspection
and
Nature's Most Uniform Deposits
of
Ball, Sagger, Enamel, Wad and Fire CLAYS

Mined and Sold by

KENTUCKY-TENNESSEE CLAY COMPANY
Mayfield, Kentucky

HIGH COLLOIDAL

BENTONITE

Carefully selected, dried at low temperature and finely pulverized.

Our deposits and plant are in the heart of the best bentonite district in Wyoming.

American Colloid Co.

Producers of Volclay Bentonite

Sales Office:
608 South Dearborn St.
Chicago, Illinois

Warehouse stocks in principal cities

SEND FOR BOOKLET

In years past it has been necessary for the enameler to use clay which had been neither inspected nor purified.

Today he is able to use a clay which has been especially prepared, purified and dried. The new clay is called Ferro "Uncommon Clay," and copy of our booklet explaining the material will be mailed upon request.

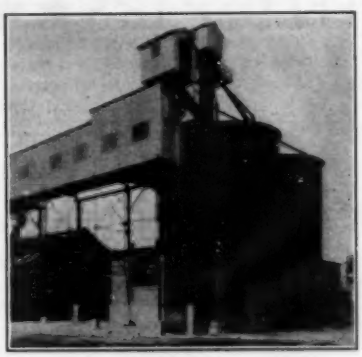
FERRO ENAMEL CORPORATION
Cleveland, Ohio

SIMPLEX ENGINEERING COMPANY

Washington Trust Building A
Washington, Pennsylvania, U. S. A.

Manufacturers of Plate Glass, Gasoline Cylinders, Battery Jars, Chemical ware, Glass Containers (Bottles), Tableware, Stemware and miscellaneous Glass Products have learned there never has been or ever will be any substitute for SIMPLEX quality?

Let SIMPLEX Engineers help you with your problems. They are at your service without obligation.



Improve your product and cut your manufacturing costs by using

SIMPLEX OIL, GAS, OR ELECTRIC LEHRS, FURNACES, TANKS, STACKERS, BATCH SYSTEMS AND PRODUCER PLANTS.

"HURRICANE" DRYERS *for YOUR PLANT*

"Hurricane" Tunnel Truck Dryer. Heat can be applied by steam, electricity, gas or waste heat from kilns.

In designing "Hurricane" Dryers, your particular requirements are taken into consideration; the nature of the product, desired capacity, available heat supply, plant layout, related production processes, etc.

The Dryer is then designed to meet the actual operating conditions with a minimum consumption of heat and power and the lowest possible cost for floor space and labor.

Truck, Automatic and Continuous Dryers for all ceramic products, including enamel ware, brick, tile, terra cotta, pottery, insulators, spark plugs and abrasive wheels.

242

THE PHILADELPHIA DRYING MACHINERY CO.

3351 Stokley Street, Philadelphia, Pa.

DRYERS for ALL Ceramic Products

FELDSPARS ★★ FLINTS

"Great Stone Face" Profile Notch, N. H.

GOLDING-KEENE COMPANY
KEENE, NEW HAMPSHIRE

THE STANDARD FLINT & SPAR CORP.
TRENTON, NEW JERSEY

SOUTHERN FELDSPAR, INC.
TOECANE, NO. CAROLINA

Near YOU Wherever YOU Are

One of Four Good Reasons—

DECREASED FUEL CONSUMPTION

THIS economy is the result of the extremely high thermal conductivity of "Carbofrax"—the Carborundum Brand Silicon Carbide Refractory. The heat is uniformly and more rapidly carried to the ware through muffle walls of this material—there is a decidedly increased heat flow in comparison with fireclay muffles.

The combustion chamber and flues are maintained at lower temperatures to do the same or more work. Little or no time is lost in the recovery of operating temperatures after the door has been opened and a cold charge introduced.

For these reasons a saving in fuel costs is obvious. With "Carbofrax" Muffles you are assured of increased production—more uniform temperature throughout the whole area of the working chamber—decreased maintenance costs—improved quality of ware.

"CARBOFRAX"

REG. U. S. PAT. OFF.

PORCELAIN ENAMELING MUFFLES

Increase Production of Better Burned Ware

THE CARBORUNDUM COMPANY

REG. U. S. PAT. OFF.

PERTH AMBOY, NEW JERSEY

Christy Firebrick Company, St. Louis — Harrison & Company, Salt Lake City

Pacific Abrasive Supply Co., Los Angeles-San Francisco

Williams & Wilson, Ltd., Montreal

(CARBORUNDUM AND CARBOFRAX ARE REGISTERED TRADE MARKS OF THE CARBORUNDUM COMPANY)

UNIFORMITY

Always and in *All Ways* M and T ENAMELS

M and T enamels are made in the newest and most modern enamel smelting plant in the country.

Each operation is conducted under the strictest of technical control. Quality of chemicals, weighing and mixing are controlled by a system that is "fool-proof."

The actual smelting is done under the direct supervision of men with years of experience in smelting enamels. Only fuel free from sulphur is used.

Quality and quantity of fuel, time, temperature, furnace atmosphere, rate of melting, degree of melting and final uniformity of melting are under strict control at all times. No detail is left to the personal opinions of the operators.

Finally each melt is subjected to an elaborate series of chemical and physical tests in which it must meet predetermined standards of quality and uniformity.

Our organization has been "SHOOTING TROUBLE" *in enamel shops for over ten years.*

It must be right in every particular or it does not go out.

Metal & Thermit Corporation

CERAMIC DEPARTMENT

HOMER F. STALEY • MANAGER
R. R. DANIELSON • DIRECTOR OF RESEARCH

120 BROADWAY, NEW YORK CITY